DELHI UNIVERSITY
LIBRARY

DELHI UNIVERSITY LIBRARY

Cl. No. MD66 G7

Ac. No. 23133 Date of release for loan

This book should be returned on or before the date last stamped below. An overdue charge of 5 Paise will be collected for each day the book is kept overtime.

ELECTRIC-WIRING DIAGRAMS

ALSO BY W. PERREN MAYCOCK

ALTERNATING CURRENT WORK

An introductory book for engineers and students. Importance, theory, alternators, transformers, motors, etc. Crown 8vo, cloth boards, 420 pp. and 260 illustrations. Second Edition. 7s. 6d. net.

ELECTRIC CIRCUIT THEORY AND CALCULATIONS

A practical book for engineers, students, contractors, and wiremen. Crown 8vo, 369 pp. and 120 diagrams. With numerous worked and unworked examples, and a part on Arithmetic. Third Edition. Revised by Philip Kemp, M.Sc., M.I.E.E., A.M.I.Mech.E., Mem. A.I.E.E. 7s. 6d. net.

ELECTRIC WIRING, FITTINGS, SWITCHES, AND LAMPS

Supply mains, distribution boards, transformers, lamps, signs, heaters, motors, bells, fire alarms, telephones, testing, etc. A practical book for all concerned with electric installation work. Crown 8vo, 646 pp., and 628 illustrations. Sixth Edition. Revised by Philip Kemp., M.Sc., M.I.E.E., A.M.IMech.E.. M.A.I.E.E. 10s. 6d. net.

ELECTRIC WIRING DIAGRAMS

Revised by H. C. Fabian. A collection, with brief explanations, of most of the diagrams given in the larger work, *Electric Wiring, Fittings, Switches, and Lamps.* Crown 8vo, 146 pp., and 246 illustrations. 5s. net.

ELECTRIC LIGHTING AND POWER DISTRIBUTION

Ninth Edition. Revised by C. H. Yeaman, *Borough Electrical Engineer, Stoke-on-Trent.* An elementary manual of electrical engineering for students preparing for the Examination of the City and Guilds of London Institute and similar examinations. In crown 8vo. Vol. I, 575 pp., with 407 illustrations. 10s. 6d. net. Vol. II, 611 pp., with 249 illustrations. 10s. 6d. net.

ELECTRIC WIRING TABLES

A collection of original and carefully verified tables for the use of electricians. Sixth Edition. Revised by F. C. Raphael, M.I.E.E. Waistcoat-pocket size, 102 pp., cloth. 3s. 6d. net.

CONTINUOUS CURRENT MOTORS AND CONTROL APPARATUS

A practical book for all classes of technical readers. Crown 8vo, with 330 pp. and 150 illustrations. 7s. 6d. net.

Sir Isaac Pitman & Sons, Ltd., Parker Street, Kingsway, London, W.C.2

ELECTRIC-WIRING DIAGRAMS

ILLUSTRATING CIRCUIT-CONNECTIONS FOR SUPPLY MAINS, DISTRIBUTION BOARDS, TRANSFORMERS, LAMPS, SIGNS, HEATERS, MOTORS, BELLS, FIRE ALARMS, PRIVATE GENERATING PLANTS, ETC., ETC.

BY

W. PERREN MAYCOCK

M.I.E.E.

(CONSULTING ELECTRICAL ENGINEER. LATE TECHNICAL EDITOR
TO THE WESTINGHOUSE COMPANIES' PUBLISHING
DEPARTMENT IN EUROPE)

SECOND EDITION

REVISED BY

H. C. FABIAN

M.R.S.T.

LONDON
SIR ISAAC PITMAN & SONS, LTD.
1937

SIR ISAAC PITMAN & SONS, LTD.
PITMAN HOUSE, PARKER STREET, KINGSWAY, LONDON, W.C.2
THE PITMAN PRESS, BATH
PITMAN HOUSE, LITTLE COLLINS STREET, MELBOURNE

ASSOCIATED COMPANIES
PITMAN PUBLISHING CORPORATION
2 WEST 45TH STREET, NEW YORK
205 WEST MONROE STREET, CHICAGO
SIR ISAAC PITMAN & SONS (CANADA), LTD.
(INCORPORATING THE COMMERCIAL TEXT BOOK COMPANY)
PITMAN HOUSE, 381–383 CHURCH STREET, TORONTO

PREFACE

ADVANTAGE has been taken of the opportunity afforded by the need for a further impression to bring this volume up to date. While *Electric Wiring, Fittings, Switches, and Lamps* still forms the basis of the book, the diagrams have been brought into line with modern practice and conventions, and where desirable new diagrams and explanations have been added.

It is hoped particularly that it will prove useful as a practical manual to those who are attending evening classes preparing for the City & Guilds of London Examinations. The reviser wishes to thank Mr. R. L. Thornton, B.Sc. (Eng.) for his assistance in preparing sketches and checking proofs.

H. C. F.

PREFACE TO FIRST EDITION

THIS volume is intended as a Reference Book of Connections for all those who are concerned with—or engaged in—electric wiring of any description; and who are already more or less familiar with the work.

The diagrams have been extracted from my *Electric Wiring, Fittings, Switches, and Lamps*, and their descriptions abbreviated. This larger book, besides many other matters, deals much more fully with the subjects of the diagrams; and gives illustrations and descriptions of distribution boards, switches, and various other apparatus indicated therein.

W. PERREN MAYCOCK.

CONTENTS

PAGE
PREFACE v
BRITISH STANDARD GRAPHICAL SYMBOLS . . . ix

SECTION I

STANDARD, SUPPLY AUTHORITIES' SERVICES 1

SECTION II

DISTRIBUTION CIRCUITS

PARAGRAPH
1. CONNECTION OF DISTRIBUTION BOARDS, ETC., TO SUPPLY MAINS 6
2. CONNECTIONS TO DISTRIBUTION BOARDS . . . 11
3. AUTOMATIC TRANSFORMER SWITCHES 18
4. GENERATING-INSTALLATION CONNECTIONS . . . 22
5. AUTOMATIC ACCUMULATOR SWITCHES 30
6. SMALL RECTIFIER PLANTS 34

SECTION III

FILAMENT-LAMP CIRCUITS, ETC.

1. METHOD OF REPRESENTING SWITCHES, ETC., IN DIAGRAMS 37
2. SIMPLE SWITCH CIRCUITS 39
3. TWO-WAY AND INTERMEDIATE SWITCH CIRCUITS . . 49
4. WHOLE - OR - PART - CIRCUIT and PARALLEL - OR - SERIES SWITCHES 63
5. THE MARVEL SWITCH 65
    5A. ORDINARY TYPE 65
    5B. ACTION 66
    5C. OTHER CIRCUITS FOR THE ORDINARY TYPE . 69
    5D. INTERMEDIATE TYPE 71
    5E. SPECIAL USES AND MODIFICATIONS . . 72
6. FULL-OR-DIM LIGHT CIRCUITS 75
7. EARTHING OF PLUG-CONNECTED FITTING . . . 81
8. CHARGING CIRCUITS FOR SMALL ACCUMULATORS . 82
9. REVERSING SWITCHES 83

SECTION IV

SIGN, HEATER, COOKER, AND MOTOR CIRCUITS

PARAGRAPH PAGE
1. SIGN CIRCUITS 84
2. HEATER CIRCUITS 93
3. COOKER CIRCUITS 95
4. MOTOR CIRCUITS
    4A. D.C. MOTORS 99
    4B. SINGLE-PHASE A.C. MOTORS 108

SECTION V

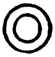
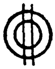
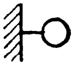
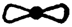
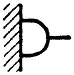
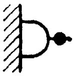
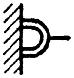
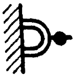
BELL, ALARM, TELEPHONE, AND CLOCK CIRCUITS

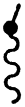
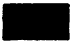
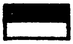
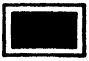
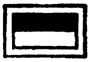
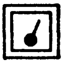
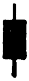
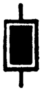
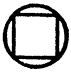
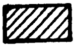
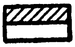
1. RULE FOR ELECTRIC BELL AND KINDRED WIRING . . 118
2. BELL CIRCUITS 119
3. BELL AND INDICATOR CIRCUITS 127
4. BELL AND RELAY-INDICATOR CIRCUITS . . . 134
5. BELL AND ELECTRICAL-REPLACEMENT-INDICATOR CIRCUITS 136
6. ALARM CIRCUITS 140
7. SIMPLE TELEPHONE CIRCUITS 144
8. CLOCK CIRCUITS 152

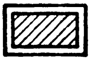
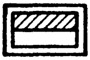
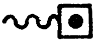
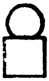
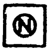
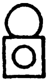
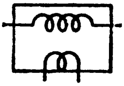
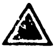
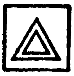
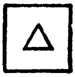
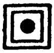
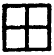
SECTION VI

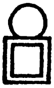
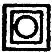
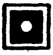
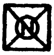
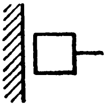
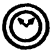
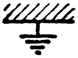
TRANSFORMER LAYOUTS 154

BRITISH STANDARD GRAPHICAL SYMBOLS
FOR USE IN CONNECTION WITH
INTERIOR ELECTRICAL INSTALLATIONS

Description	*Symbol*
1. Ceiling Point, Lighting	
2. Ceiling Point, Power	
3. Floor Point, Lighting	
4. Floor Point, Power	
5. Bracket Point, Lighting.	
6. Fan Point	
7. Synchronous Clock Point	
8. Special Purposes Point	
9. Lighting Wall-socket	
10. Lighting Wall-socket and Switch combined	
11. Power Wall-socket	
12. Power, Wall-socket and Switch combined.	

Description	*Symbol*
13. 1-way Switch	
14. 2-way Switch	
15. Intermediate Switch	
16. Pear Switch for Lighting	
17. Main Fuseboard without Switches, Lighting	
18. Main Fuseboard with Switches, Lighting	
19. Main Fuseboard without Switches, Power	
20. Main Fuseboard with Switches, Power	
21. Main Switch, Lighting	
22. Main Switch, Power	
23. Main Cut-out, Lighting	
24. Main Cut-out, Power	
25. Meter	
26. Distribution Fuseboard without Switches, Lighting	
27. Distribution Fuseboard with Switches, Lighting	

Description	*Symbol*
28. Distribution Fuseboard without Switches, Power	
29. Distribution Fuseboard with Switches, Power	
30. Bell Push	
31. Pear Push and Rosette	
32. Bell	
33. Bell Indicator (N = No. of Ways)	
34. Indicator and Bell	
35. Bell-ringing Transformer	
36. Telephone Point, public service	
37. Telephone Board, public service	
38. Telephone Point, internal	
39. Telephone Board, internal	
40. Fire Push	
41. Automatic Alarm	

Description	*Symbol*
42. Fire Gong	
43. Fire Indicator	
44. Remote Control Push	
45. Special Purposes Push	
46. Special Purposes Indicator (*N* = No. of Ways)	
47. Loud-speaker Outlet	
48. Master Clock	
49. Secondary Clock	
50. Earth Point	

The foregoing list of symbols is abstracted by permission from British Standard Specification No. 447—1932, *British Standard Graphical Symbols for use in connection with Interior Electrical Installations*; official copies of which can be obtained from the British Standards Institution, 28 Victoria Street, London, S.W.1, price 1s. 2d., post free.

ELECTRIC-WIRING DIAGRAMS

SECTION I

STANDARD SUPPLY AUTHORITIES' SERVICES

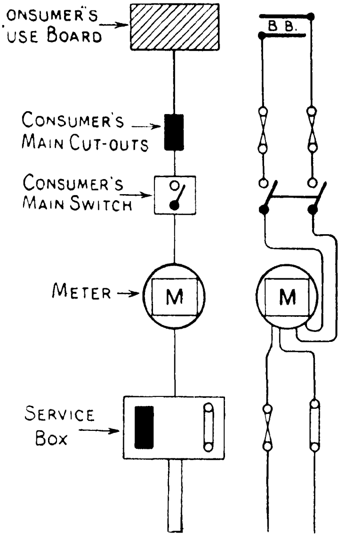


FIG. 1. LIGHTING AND HEATING COMBINED

The left hand portion of the diagram shows the circuit as represented in conventional symbols: the right hand portion shows it in greater detail.

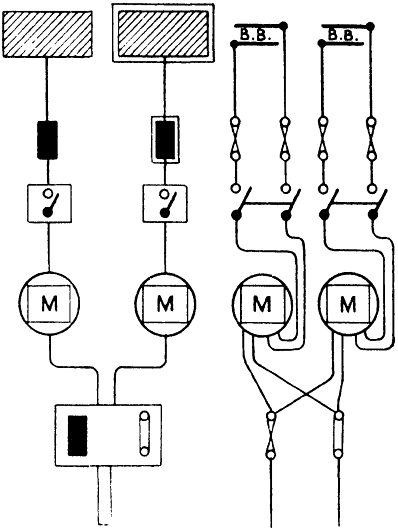


FIG. 2. SEPARATE SUPPLIES FOR LIGHTING AND POWER

The left hand portion of the diagram shows the circuit as represented in conventional symbols: the right hand portion shows it in greater detail.

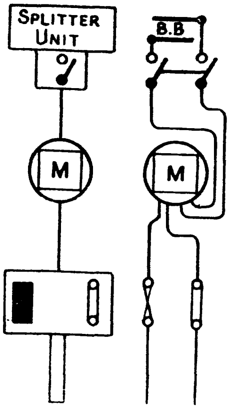


FIG. 3. SMALL LIGHTING SUPPLY

The left hand portion of the diagram shows the circuit as represented in conventional symbols: the right hand portion shows it in greater detail.

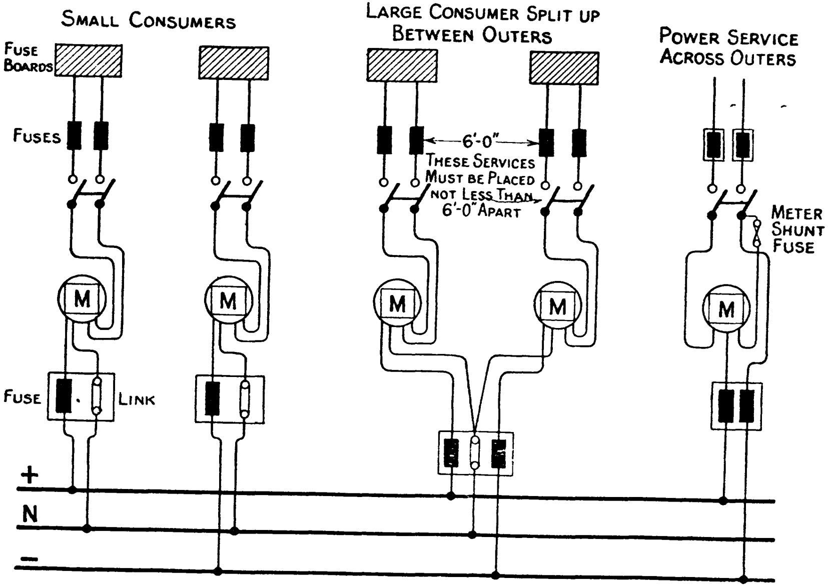

SMALL CONSUMERS
FUSE BOARDS
FUSES
FUSE
LINK
M
M
LARGE CONSUMER SPLIT UP BETWEEN OUTERS
6'-0"
THESE SERVICES MUST BE PLACED NOT LESS THAN 6'-0" APART
M
M
POWER SERVICE ACROSS OUTERS
METER SHUNT FUSE
M
+
N
−

FIG. 4. TYPICAL THREE-WIRE D.C. SYSTEM

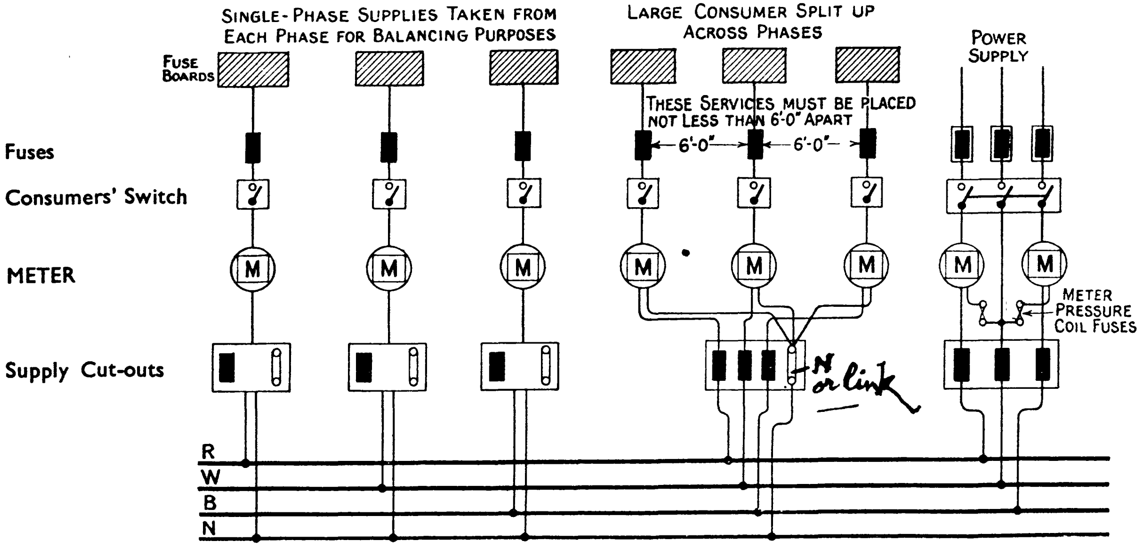

SINGLE-PHASE SUPPLIES TAKEN FROM EACH PHASE FOR BALANCING PURPOSES
LARGE CONSUMER SPLIT UP ACROSS PHASES
POWER SUPPLY
FUSE BOARDS
THESE SERVICES MUST BE PLACED NOT LESS THAN 6'-0" APART
6'-0"
6'-0"
Fuses
Consumers' Switch
METER
M
Supply Cut-outs
METER PRESSURE COIL FUSES
N or link
R
W
B
N

FIG. 5. TYPICAL FOUR-WIRE THREE-PHASE DISTRIBUTION SYSTEM

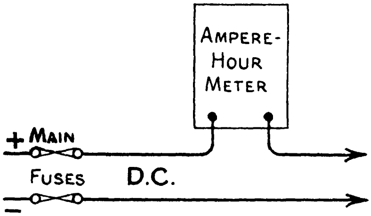


FIG. 6. AMPERE-HOUR METER CONNECTIONS

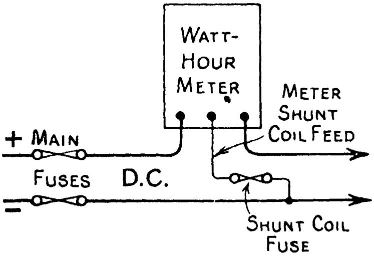


FIG. 7. WATT-HOUR METER CONNECTIONS

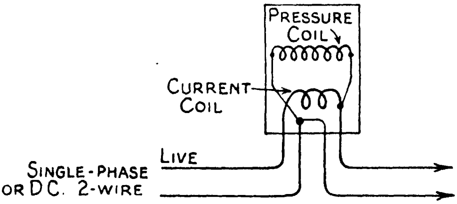


FIG. 8. INTERNAL CONNECTIONS OF D.C. AND A.C. WATTMETERS

Small Consumers.

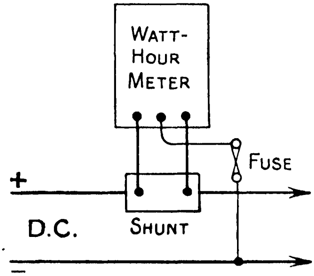


FIG. 9. HEAVY CURRENT CIRCUIT WATT-HOUR METER CONNECTIONS

Direct Current

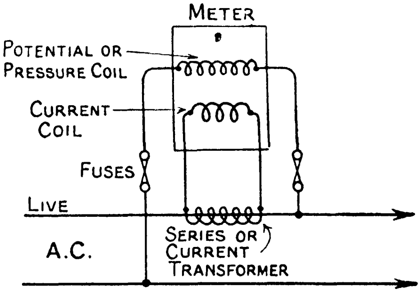


FIG. 10. HEAVY CURRENT CIRCUIT WATT-HOUR METER CONNECTIONS

Alternating Current

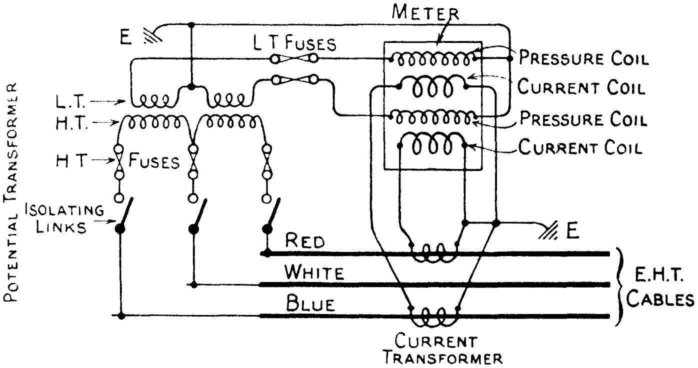


FIG. 11. TYPICAL THREE-PHASE METERING SYSTEM FOR H.T. SUPPLY

SECTION II

DISTRIBUTION CIRCUITS

¶ 1. Connection of Distribution Boards, etc., to Supply Mains

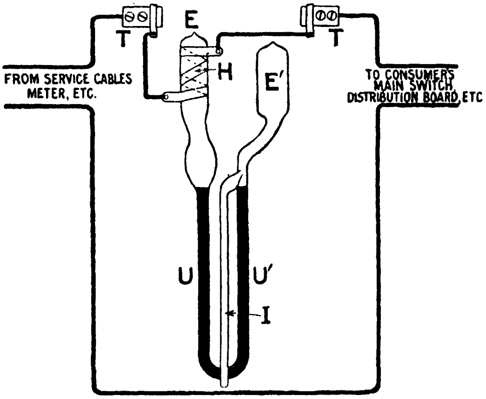

T
E
T
H
E′
FROM SERVICE CABLES METER, ETC.
TO CONSUMER'S MAIN SWITCH DISTRIBUTION BOARD, ETC
U
U′
I

FIG. 12. WRIGHT MAXIMUM DEMAND INDICATOR

T, *T*, terminals; *H*, heating strip; *E*, *E′*, air bulbs; *U*, *U′*, legs of U-tube filled with mercury; *I*, overflow indicator tube.

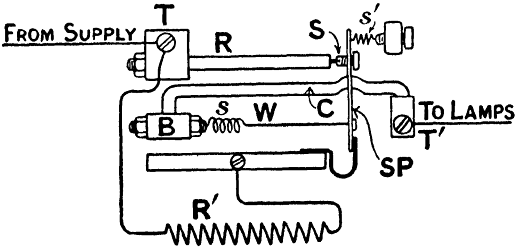


FIG. 13. CURRENT LIMITER
(*Nalder Bros. & Thompson*)

The current flows from *T* to *T′* *via* the metal rod *R*, contact screw *S*, spring support *SP*, heating wire *W*, spring *s*, block B, and conducting strip *C*.

If the current exceeds the normal, *W* elongates sufficiently for *s′* to pull *S* away from *R*; the circuit being then shunted through the resistance *R′*, which dims the lamps. As long as the current, or in other words, the number of lamps in circuit, is excessive, contact will be repeatedly broken and made at *S*, and the lamps will flicker.

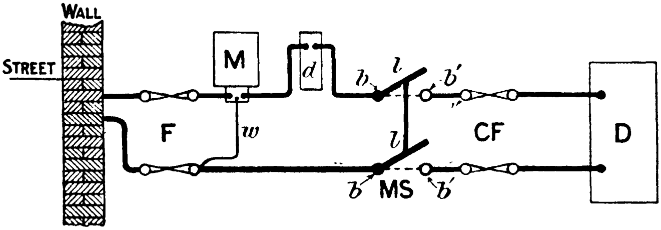


FIG. 14. CONNECTION OF DISTRIBUTION BOARD TO TWO-WIRE STREET MAINS

F, *M*, and *d*, supply authority's fuses, meter, and demand indicator; *w*, shunt wire of meter. *MS*, *CF*, and *D*, consumer's main switch, fuses, and distribution board.

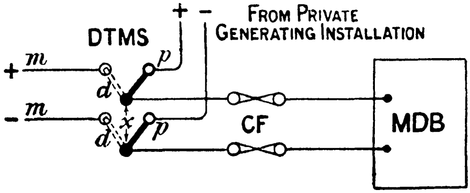


FIG. 15. CONNECTION OF DISTRIBUTION BOARD TO ALTERNATIVE TWO-WIRE SOURCES OF SUPPLY

DTMS, double-throw or two-way main switch. *CF*, and *MDB*, consumer's fuses, and main distribution board; *m*, *m*, point of connection to supply authority's meter and fuses.

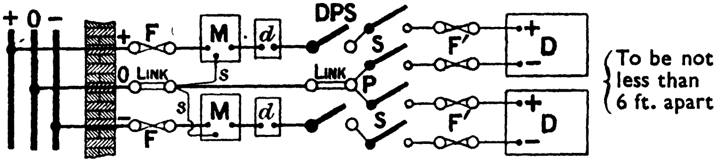


FIG. 16. CONNECTION OF DISTRIBUTION BOARDS TO THREE-WIRE STREET MAINS

F, *F*, *M*, *M*, and *d*, *d*, supply authority's fuses, meters, and demand indicators; *s*, *s*, shunt wires of meters. *DPS*, double-pole switch on outers of three-wire system; *P*, branching point of system. *S*, *S*; *F′*, *F′*; *D*, *D*; consumer's two-pole main switches, fuses, and distribution boards.

FIG. 17 (*See opposite page*)

CB, circuit-breakers; *M*, meters; *s*, meter shunt wires; *S*, *S*, and *F*, *F*, main I.C. switches and fuses on outers; *L*, links on neutral mains. I, II, III, IV, pairs of bus-bars on main switchboard. *D*1, *D*2, distribution boards on + and – sides of system. *COS*, *COS′ F′*, *F′*, change-over switches and fuses connecting distribution boards to bus-bars. *P* = power distribution board. *COS* and *COS* are linked together so that *D*1 and *D*2 are always on opposite poles of either station *A* or station *B*. The same applies to *COS′* and *COS′*. The actual installation comprises a number of change-over switches and distribution boards.

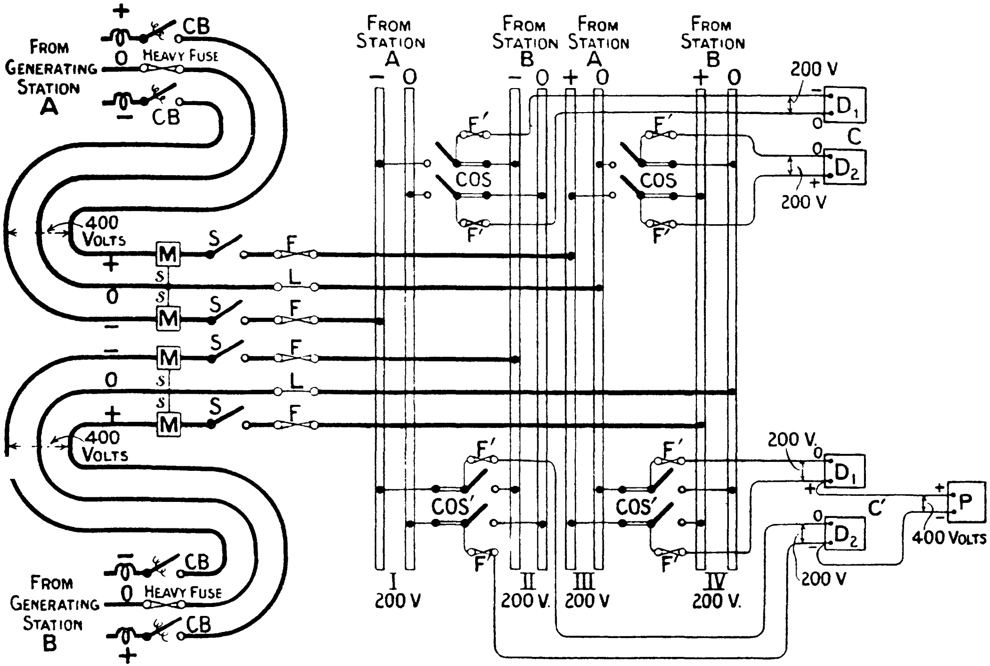


FIG. 17. DOUBLE THREE-WIRE D.C. SUPPLY FROM TWO GENERATING STATIONS.*

* Manchester Royal Infirmary. Consulting Engineers: Messrs. Miller, Wilson & Pegg. Contractors for Main Switchboard, etc.: Messrs. Bertram Thomas.

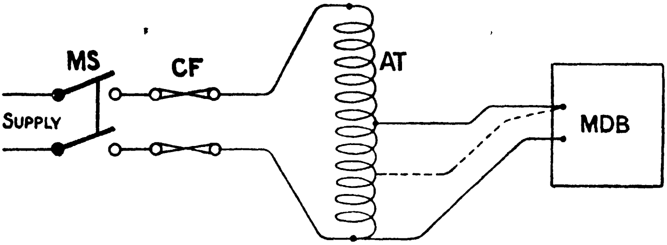


Fig. 18. Supply through Auto-transformer

AT, auto-transformer; *MDB*, main distribution board. *MS* and *CF*, consumer's main switch and fuses.

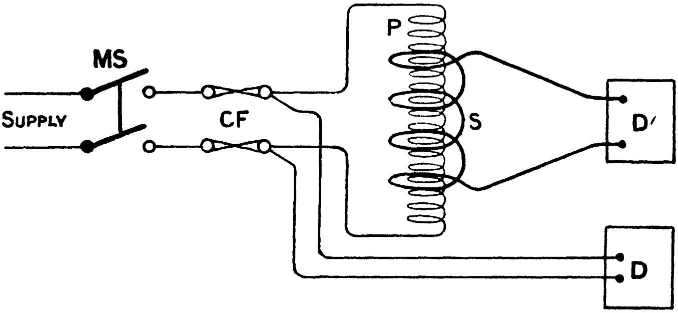


Fig. 19. Distribution at Two Pressures

MS, main switch, *CF*, consumer's fuses; *D* distribution board at full pressure; *P*, *S*, primary and secondary of transformer; *D′*, distribution board at reduced pressure.

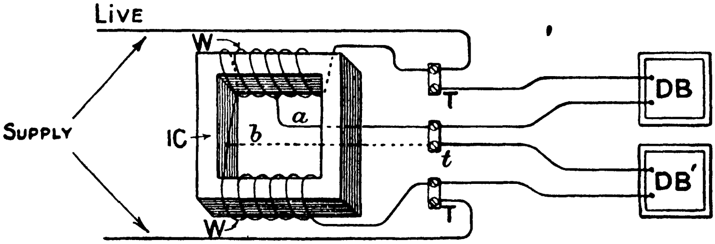


FIG. 20. CONNECTION OF ONE OR TWO DISTRIBUTION BOARDS TO TRANSFORMING DEVICE

IC, iron core; *W*, *W*, winding; *DB*, *DB′*, distribution boards. If *DB* be used alone, and *t* be connected through *a*, the pressure will be one-fourth the total. If *DB′* be used alone, and *t* connected through *a*, the pressure will be three-fourths the total. If either *DB* or *DB′* be connected through *b*, the pressure will be half the total. In all the above cases the devise acts as an auto-transformer.

If both *DB* and *DB′* be connected through *b*, the pressure at each board will be half the total, and the device will act as a balancer.

N.B.—Figs. 23 and 25 to 36 also show connections to supply mains.

¶ 2. Connections to Distribution Boards

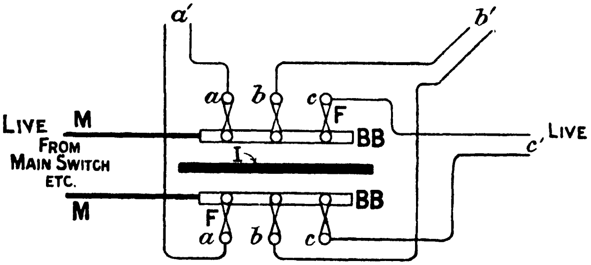


FIG. 21. THREE-WAY BOARD

M, mains; *BB*, bus-bars; *I*, insulating partition; *F*, fuses; ***aa***, ***bb***, *cc*, ways; *a′*, *b′*, *c′*, wires to lamp and other circuits.

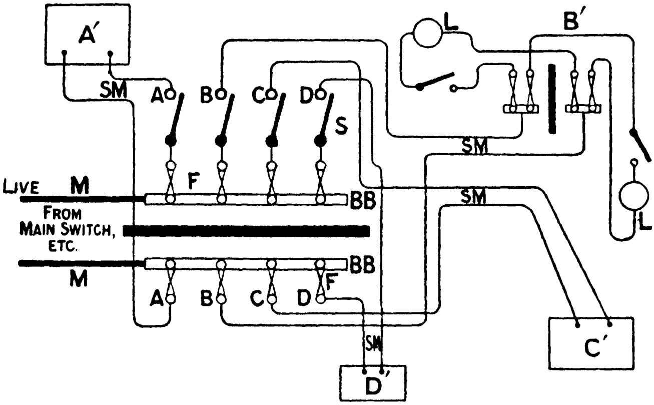


Fig. 22. Main Switch- and Fuse-board connected to Sub-boards

M, mains; *BB*, bus-bars; *F*, fuses; S, switches; *A*, *B*, *C*, *D*, circuit terminals; *SM*, sub-mains; *A′*, *B′*, *C′*, *D′*, sub-boards; L, lamp circuit.

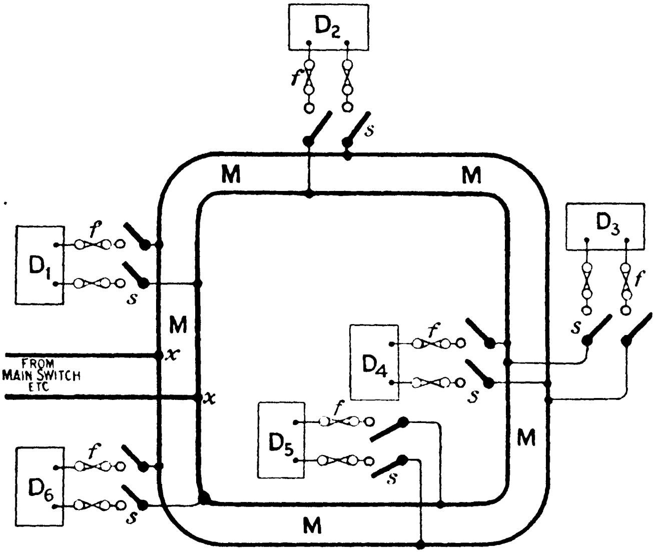


FIG. 23. CONNECTION OF DISTRIBUTION BOARDS TO RING MAINS

M, *M*, ring mains; *x*, *x*, point of connection to supply mains; *D*1 – *D*6, distribution boards; *s*, switches; *f*, fuses.

This system is frequently used to-day in large modern buildings and flats.

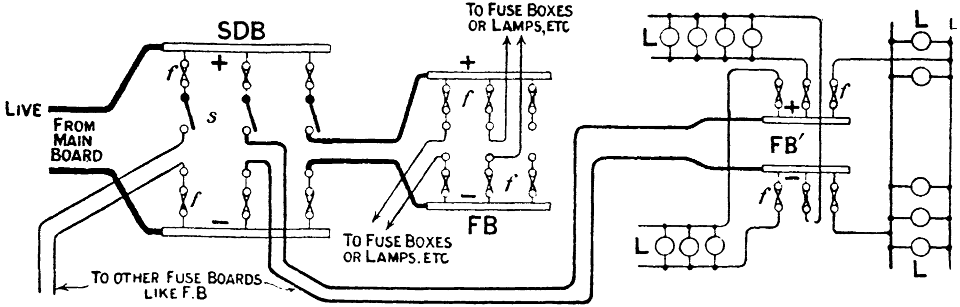

SDB
+
f
s
LIVE
FROM MAIN BOARD
f
–
TO OTHER FUSE BOARDS LIKE F.B
TO FUSE BOXES OR LAMPS, ETC
+
f
f
–
FB
TO FUSE BOXES OR LAMPS. ETC
L
L
+
f
FB′
f
–
L
L
L

FIG. 24. CONNECTION OF SUB-DISTRIBUTION BOARD TO FUSE-BOARDS FUSE-BOXES, ETC.

SDB, sub-distribution switch-and-fuse board fed from one of the ways on a main board. *FB*, fuse-board; *FB′*, fuse-box; *s*, switches, *f*, fuses; *L*, lamp or other consuming circuits.

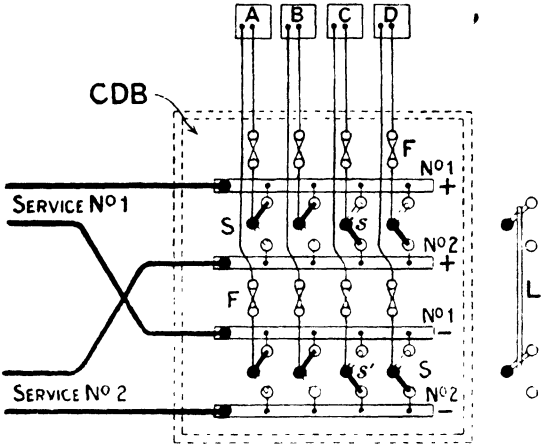


FIG. 25. DISTRIBUTION BOARDS CONNECTED TO MAIN CHANGE-OVER BOARD WITH DOUBLE SUPPLY, D.C.

A–D, distribution boards; *CDB*, change-over board, with fuses *F*, and two-way switches *S*. Each pair of switches, as *s* and *s'*, is linked together as at *L*.

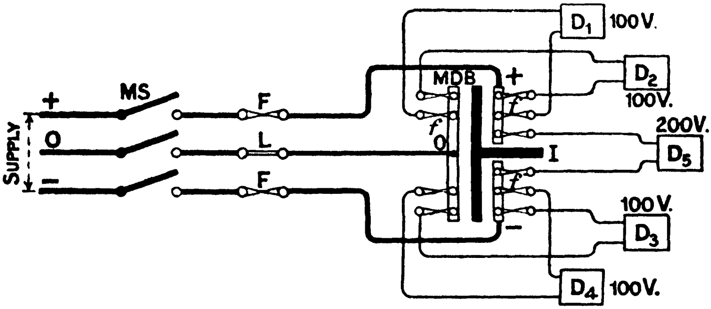


FIG. 26. THREE-WIRE DISTRIBUTION BOARD

MS, *F*, *F*, main triple-pole switch (neutral blade makes first and breaks last) and double-pole fuses; *L*, neutral link. *MDB*, three-wire-main board; *I*, insulating partition; *f*, fuses. *D*1–*D*4, two wire sub-boards.

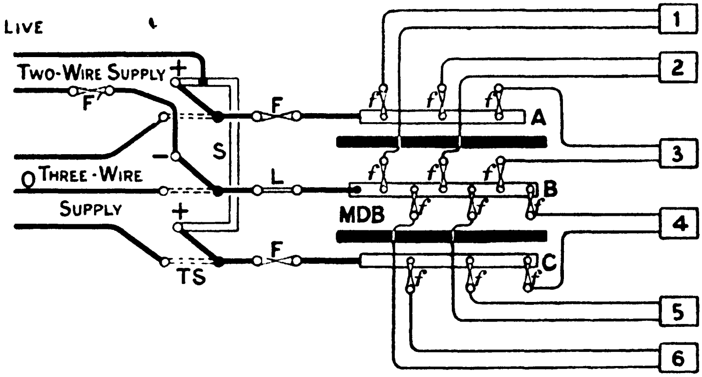


Fig. 27. Alternative Two- or Three-wire Supply, D.C.

S, consumer's special main triple-pole change-over switch; *F*, *F*, consumer's main fuses, *L*, link in middle wire; *MDB*, main distribution board; *A*, *B*, *C*, bus-bars; *f*, fuses; 1–6, sub-distribution boards.

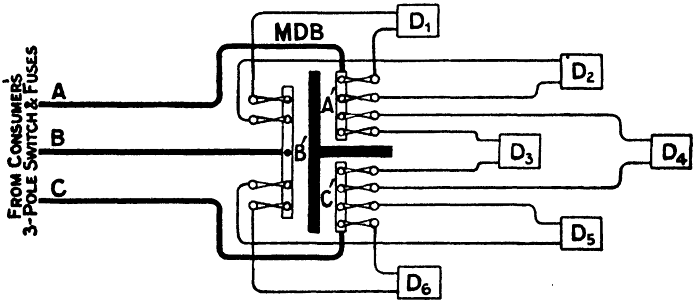


Fig. 28. Three-phase Three-wire Distribution Board

A, *B*, *C*, three-phase mains; *MDB*, main distribution board; *A′*, *B′*, *C′*, phase bus-bars; *D*1–*D*6, two-wire sub-distribution boards. Live pressure across supply boxes *D*.

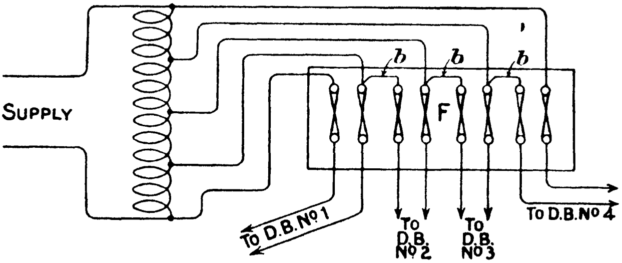


FIG. 29. CONNECTION OF BALANCING TRANSFORMER TO SPECIAL MAIN DISTRIBUTION BOARD

F, fuses; *DB*, sub-distribution boards. *b*, Connections to feed adjacent circuits.

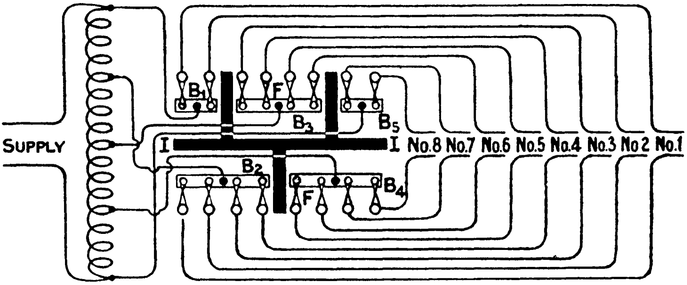
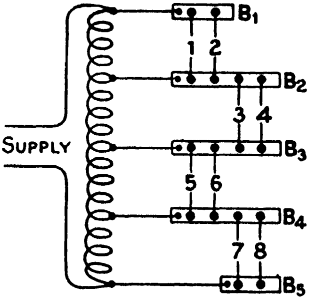


FIG. 30. CONNECTION OF BALANCING TRANSFORMER TO SPECIAL MAIN DISTRIBUTION BOARD



*B*1–*B*5, bus-bars of main distribution board; *I*, insulating partition; *F*, fuses; *No.* 1, *No.* 2, etc., leads to sub-boards. This arrangement is rendered clearer by Fig. 31.

FIG. 31

¶ 3. Automatic Transformer Switches

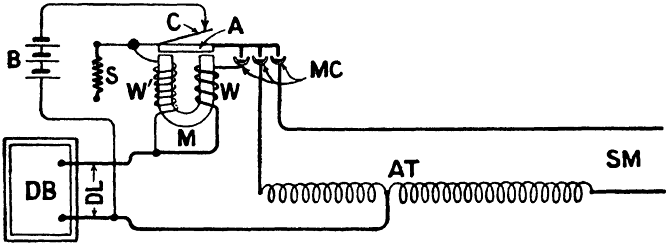


FIG. 32. DIAGRAM OF THE "BRUSTON" AUTOMATIC TRANSFORMER SWITCH (*Morris & Lister*)

SM, supply mains; *AT*, auto-transformer; *DL*, distribution leads; *DB*, distribution board; *M*, electro-magnet; *W*, *W'*, thick and thin windings of *M*; *A*, armature; *C*, contact spring; *S*, pull-off spring; *MC*, mercury cups; *B*, dry battery.

When the first lamp is switched on, the circuit of *B* is completed through *W'*, *A* is drawn down, the transformer circuit closed through *MC*, and *B* open-circuited at *C*. As long as any lamps are on, *W* holds *A* down. When the last lamp is turned off, *A* is released, the supply circuit broken at *MC*, and contact made again at *C* in readiness for the next switching-on.

The "Bruston" switch is adapted for connection to a double-wound or ordinary transformer as shown in Fig. 33.

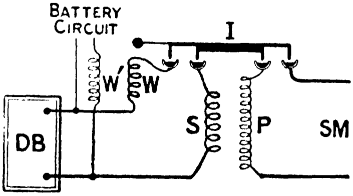


FIG. 33. DIAGRAM OF THE "BRUSTON" AUTOMATIC TRANSFORMER SWITCH MODIFIED FOR USE WITH AN ORDINARY TRANSFORMER

SM, supply mains; *DB*, distribution board; *P* and *S*, primary and secondary windings of the transformer; *W*, *W'*, thick and thin windings of electro-magnet; *I*, insulating portion between the two dippers. *B*, *C*, *M*, *A*, and *S* as in Fig. 32.

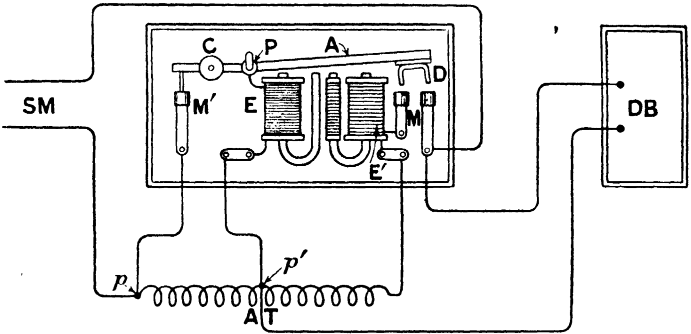


Fig. 34. Burr's Automatic Transformer Switch for Low Distribution Board Pressures

SM, supply mains; *AT*, auto-transformer; *DB*, distribution board.

Directly one or more lamps are turned on, there is a small current through that portion of *AT* between *p* and *p′*; and as there is then a difference of pressure between these points, a current flows through the high-resistance coil of the electro-magnet *E*. This causes the armature *A*, pivoted at *P*, to be attracted; and the dipper *D* to enter the mercury cups *M*, the circuit of *E* being then broken at the mercury cup *M′*. The circuit of *AT* is thus completed through the thick-wire coil of the second electro-magnet *E′*, and the lamps light up.

As long as current is drawn through *DB*, *E′* will hold *A* firmly down; but directly this current ceases, the circuit will be broken between *D* and *M*. That this should happen is not quite clear at first, as there is a complete circuit between the supply mains, through the auto-transformer, *E′*, *M*, and *D*. This current, however, is not sufficient to hold down *A* against the counterweight *C*.

On the left-hand leg of *E′* is a small coil of wire, the ends of which are short-circuited. This tends to keep the strength of the electro-magnet from increasing when more and more lamps are turned on, and the current through *E′* increases. In other words, the short-circuited coil partly neutralises the effect of *E′*. If the magnet increased in strength, there would be a tendency for the armature *A* to vibrate and emit a humming noise.

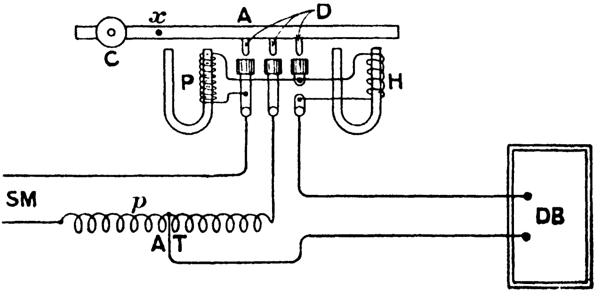


FIG. 35. DIAGRAM OF BURR'S AUTOMATIC TRANSFORMER SWITCH FOR ORDINARY DISTRIBUTION BOARD PRESSURES

This is a modication of the apparatus illustrated in Fig. 34. The magnets and coils are shown diagrammatically, and the short-circuited coil omitted.

When a circuit is completed through *DB*, the high-resistance pull-on coil *P*, in series with the hold-on coil *H*, is energised by a small current flowing through *DB* and the primary half *p* of the auto-transformer *AT*. The armature *A*, pivoted at *x*, is then attracted; and the three-legged dipper *D* enters the mercury cups between the two magnets. This completes the circuit of the auto-transformer through the hold-on magnet *H*; *P* being then short-circuited. As soon as all lamps are turned off, *H* is de-energised; and the counterweight *C* pulls *A* away from the magnet poles, and the dipper out of the mercury cups.

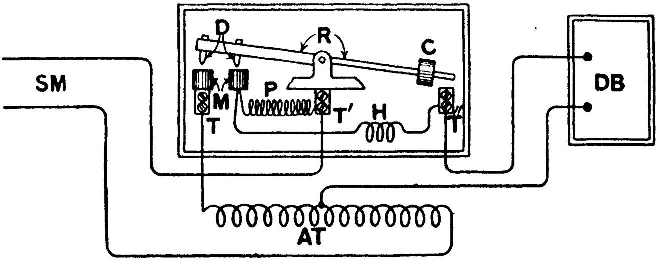


FIG. 36. DIAGRAM OF AUTOMATIC TRANSFORMER SWITCH
(*Foster*)

The figure illustrates the principle only, the construction being such that a view of the actual mechanism would not enable the action to be clearly understood.

The moving portion consists of a pivoted rocker *R*, carrying dipper contacts *D* and a counterweight *C*. *P* stands for the very fine high-resistance winding of a pull-on magnet, and *H* for the thick low-resistance winding of a hold-on magnet. *SM* are the supply mains, *AT* the auto-transformer, and *DB* the distribution board. *T*, *T′*, and *T″* are the three terminals, and *M* the mercury cups.

When any circuit from *DB* is closed, a very small current flows *via T′*, *P*, *H*, *T″*, *DB*, and part of *AT*. This energises the pull-on magnet *P*, and *D* dips into *M*. *P* is thereupon short-circuited; but the current flowing through *H* being then much stronger, even if it be only that necessary for one lamp, *H* will hold *R* down firmly in the " on " position. Directly the last lamp is turned off, *H* loses its magnetism, and *C* causes *R* to tilt once more as shown in the figure; the dipper contacts being withdrawn from the mercury cups, and the auto-transformer circuit broken.

¶ 4. Generating-installation Connections

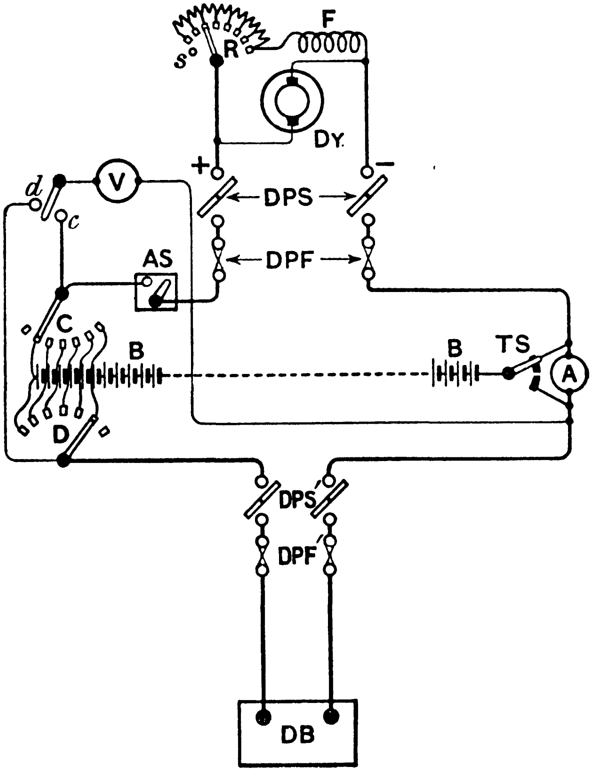


FIG. 37. DYNAMO-ACCUMULATOR INSTALLATION

Dy = Dynamo.
F = Field-winding of dynamo.
R = Rheostat for regulating dynamo e.m.f., with stop *s* to prevent circuit being broken.
DPS, *DPS′* = Double-pole switches in dynamo and supply circuits respectively.
DPF, *DPF′* = Double-pole fuses in dynamo and supply circuits respectively.
B–B = Battery of accumulators.

C = Multiple-way switch for regulating number of cells "on charge."

D = Multiple-way switch for regulating number of cells "on discharge."

V = Voltmeter which indicates the charging or discharging pressure, according as its two-way switch is placed on *c* or *d*.

AS = Automatic accumulator switch for closing the charging circuit when the voltage of the dynamo rises above that of the battery, and for breaking it if the voltage falls below. (*See* Figs. 30–33.)

A = Ammeter. This shows the current in the dynamo circuit when the two-way switch *TS* is on its bottom contact; and the current in the distribution-board circuit when *TS* is on its top contact.

DB = Distribution board.

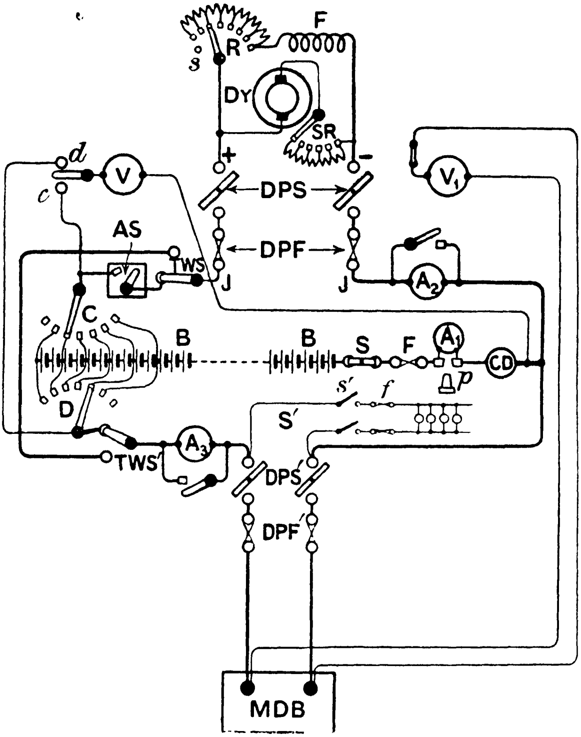


FIG. 38. DYNAMO-ACCUMULATOR INSTALLATION

Dy = Dynamo.

F = Field-winding of dynamo.

R = Rheostat for regulating the dynamo e.m.f. Also for regulating the speed of the machine when it is used as a motor to start the engine, current being taken from the accumulators for this purpose. The stop *s* prevents the circuit being broken.

SR = Starting rheostat for introducing resistance into the armature circuit when the machine is used as a motor to start the engine.

J, *J* = Points of connection of extra dynamo, or dynamos, when two or more generators are installed.

DPS, *DPS′* = Double pole switches in dynamo and supply circuits respectively.

DPF, *DPF′* = Double-pole fuses in dynamo and supply circuits respectively.

B, *B* = Battery of accumulators.

C = Multiple-way switch for regulating number of cells "on charge."

D = Multiple-way switch for regulating number of cells "on discharge."

MDB = Main distribution board.

V = Voltmeter which indicates the charging or discharging pressure, according as its two-way switch is placed on *c* or *d*.

V_1 = Voltmeter in dynamo room for indicating the supply pressure at *MDB*, which is presumed to be some distance away.

CD = Current-direction indicator to show if the battery is charging or discharging.

F = Single-pole fuse in battery circuit, to prevent very excessive charge or discharge.

S = Single-pole switch in battery circuit to enable it to be disconnected from the dynamo and supply circuits when cleaning or repairs are necessary. *C* and *D* are provided with off positions for the same purpose.

TWS, *TWS′* = Two-way switches to enable the dynamo and supply circuits to be interconnected without the battery.

AS = Automatic accumulator switch for closing the charging circuit when the voltage of the dynamo rises above that of the battery; and for breaking it if the voltage falls below. (*See* Figs. 30–33.)

A_1 = Ammeter (with short-circuiting plug *p*) in battery circuit.

A_2 = Ammeter (with short-circuiting switch) in dynamo circuit.

A_3 = Ammeter (with short-circuiting switch) in supply circuit

S′ = Supply circuit for lamps, etc., in engine, dynamo, and accumulator rooms.

s′ = Small double-pole switch for *S′*.

f = Small double-pole fuse for *S′*.

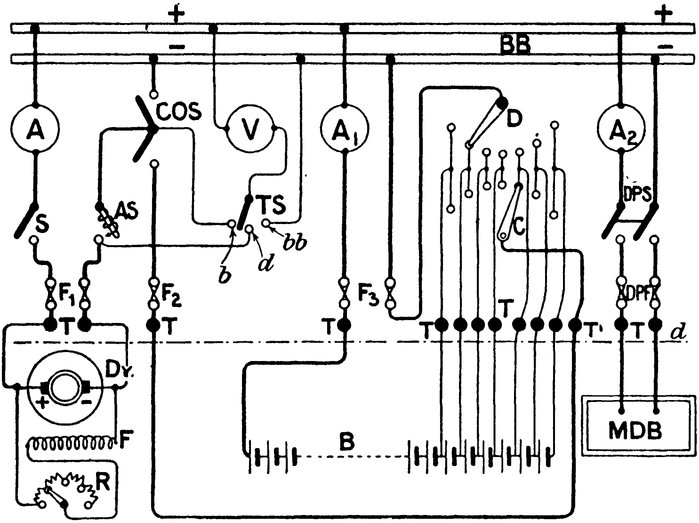


FIG. 39. DYNAMO-ACCUMULATOR INSTALLATION

Dy = Dynamo.
F = Field-winding of dynamo.
R = Rheostat for regulating e.m.f. of dynamo.
T, *T*, *T*, etc. = Terminals on switchboard.
BB = Bus-bars on switchboard.
F_1 = D.p. fuse in dynamo circuit.
S = S.p. switch in dynamo $+^{ve}$ lead.
AS = Automatic accumulator switch in dynamo $-^{ve}$ lead. (*See* Figs. 30–33.)
A = Ammeter in dynamo circuit.
COS = Change-over or two-way "off" switch to enable dynamo $-^{ve}$ lead to be connected to battery or bus-bars at will.
F_2 = Single-pole fuse in dynamo $-^{ve}$ lead to battery.
B = Battery of accumulators.
F_3 = Double-pole fuse in battery leads to bus-bars.
A_1 = Ammeter in battery circuit.
C and *D* = Charge and discharge regulating switches.
A_2 = Ammeter in distribution leads.
DPS = Double-pole switch in distribution leads.
DPF = Double-pole fuse in distribution leads.
MDB = Main distribution board.

V = Voltmeter.

TS = Three-way switch for connecting voltmeter to bus-bars (contact *bb*), dynamo (contact *d*), or battery (contact *b*) circuits respectively. *N.B.* Contact (*b*) only gives the battery voltage when *COS* is on its lower contact. If *COS* be on its top contact, both *b* and *bb* will give the bus-bar pressure.

d = Dividing line of connections. All those above the line are on the switchboard itself.

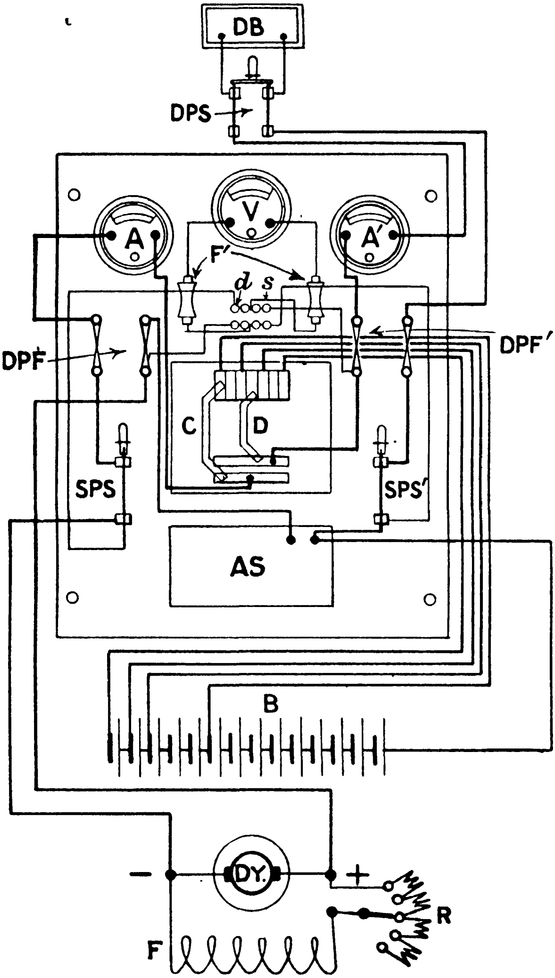


FIG. 40. DYNAMO-ACCUMULATOR INSTALLATION FOR 25-VOLT PRESSURE
(*Drake & Gorham*)

In Fig. 40—

Dy = Dynamo.

F = Field-winding of dynamo.

R = Rheostat for regulating the dynamo. e.m.f.

SPS, *SPS′* = Single-pole switches in the dynamo and supply circuits respectively.

DPF. *DPF′* = Double-pole fuses in the dynamo and supply circuits respectively.

B = Battery of accumulators (14 cells).

AS = Automatic accumulator switch. (*See* Figs. 30–33.)

C = Switch for regulating the number of cells "on charge."

D = Switch for regulating the number of cells "on discharge."

V = Voltmeter indicating the pressure of the dynamo or supply circuits, when the 4-pin connecting plug is placed in the 4-hole sockets *d* or *s* respectively.

F′ = Double-pole fuse in voltmeter circuit.

A, *A′* = Ammeters showing the dynamo and supply currents respectively.

DPS = Double-pole switch in the supply circuit.

DB = Distribution board.

¶.5. Automatic Accumulator Switches

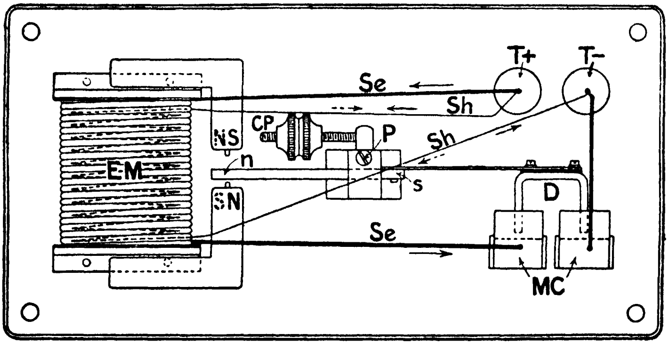


Fig. 41. "Nevile" Automatic Accumulator Switch
(Drake & Gorham)

EM is an electro-magnet with shunt and series coils, the ends of which are shown at *Sh*, *Sh*, and *Se*, *Se*. The shunt coil is permanently connected to the terminals *T* + and *T* −; and the current through it is consequently proportional to the pressure at these terminals, which are connected in one of the leads running between the dynamo and the battery. One end of the series coil is joined-up to one of the terminals, and the other to one of the two mercury cups *MC*; the other cup being connected to the other terminal. The dipper *D* is fixed at the end of a rod pivoted at *P*, and the rod carries the permanent bar-magnet *n*, *s*, at its other end. *CP* is a counterpoise.

The dynamo tends to send current one way through the apparatus, while the battery tends to send current through the other way. Should the battery e.m.f. be greater than the dynamo e.m.f., the polarity of the terminals will be opposite to that marked; and a current will flow round the shunt circuit in the direction indicated by the dotted arrows. The polarity of *EM* will then be as shown by the dotted N and S, and will keep the *n* end of the permanent magnet down, and *D* out of *MC*. Directly the dynamo e.m.f. becomes greater than that of the battery, the terminals will have the polarity indicated in the figure; and a current will flow round the shunt circuit in the direction indicated by the full-line arrows. The polarity of *EM* will then alter to S and N, thus tending to move the *n* end of the permanent magnet upwards. When the dynamo e.m.f. still further increases, *n* will move up to the top pole of *EM*, *D* will dip into *MC*, and the main circuit will be closed. A current will then flow through the series winding *Se* in such a direction as to increase the *S*, *N* polarity. Thus the end *n* of the permanent magnet will be kept tilted up, and *D* in *MC*.

Should the current fall to zero, owing to a drop in the dynamo e.m.f., or to the battery e.m.f. rising to that of the dynamo, the polarity of *EM* will weaken, and *CP* will eventually pull *D* out of *MC*.

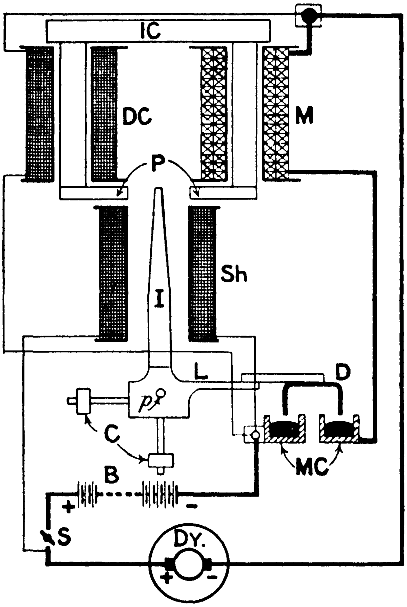


FIG. 42. "CRAWLEY" AUTOMATIC ACCUMULATOR SWITCH
(*Nalder Bros. & Thompson*)

This figure gives both internal and external connections, the latter being simplified, and showing only plain dynamo and battery circuits. The heavy lines indicate the main current circuit, and the fine lines the shunt circuits. The terminals are omitted from the diagram.

On closing the main switch *S*, the shunt coil *Sh* is connected in parallel with the battery. It therefore magnetises the movable iron core *I*, which is fixed on (and just above the pivot *p* of) the lever *L* carrying the dipper *D*. The *difference coil DC* is in series with the dynamo and accumulator when *D* is out of the mercury cups. It is so-called because it carries a current whose direction and strength depend on the difference between the e.m.f.'s of the dynamo and accumulator. *DC* imparts polarity to the extremities *P* of the iron core *IC*, which carries *DC* on one leg and the main coil *M* on the other.

As soon as the dynamo e.m.f. exceeds that of the battery by about 6 volts, the polarity of *P* is such as to tilt *I* to the right, and cause *D* to enter the mercury cups *MC*; so completing the main circuit. In other words, the —^{ve} end of the cells and of the dynamo are connected through the coil *M*; and the battery-charging current which then flows through *M* holds the dipper firmly in the cups.

When the dynamo voltage falls, the current in *M* decreases; and eventually the dipper is pulled out of the cups by the action of gravity on the counterweights *C*. The breaking of the circuit occurs at the moment when the current is practically at zero, and there is consequently little or no sparking in the mercury cups.

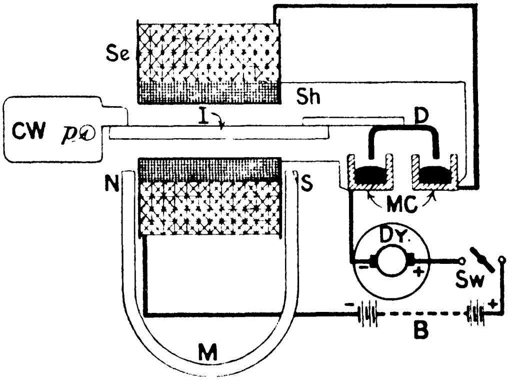


FIG. 43. "MIDGET" AUTOMATIC ACCUMULATOR SWITCH
(*Nalder Bros. & Thompson*)

The preliminary remarks under Fig. 42 apply here also.

B, Accumulator battery; *Dy*, dynamo; *Sw*, main switch.

Se and *Sh*, series and shunt windings of automatic switch; *N*, *S*, poles of permanent magnet *M*, *I*, *CW*, and *D*, armature, counterweight, and dipper, pivoted at *p*. *MC*, mercury cups.

When *Sw* is closed, current will flow round *Sh* in one direction or the other, according as the dynamo e.m.f. is greater or less than that of the battery. If both e.m.f.'s are equal, no current will flow.

If the battery e.m.f. is the greater, the current round *Sh* will be in such a direction as to make the left-hand end of *I* of N polarity, and the right-hand end of S polarity. *M* will then repel *I*, and *D* will be kept out of *MC*.

If the dynamo e.m.f. is greater than that of the battery, the current through *Sh* will be in the opposite direction, and will make the left-hand end of *I* of S polarity, and the right-hand end of N polarity. The consequent attraction between *M* and *I* will then overcome the gravitating force of *CW*, and *D* will dip into *MC*, thus completing the main circuit. This will short-circuit *Sh*, but the main current flowing round *Se* will cause *D* to be held down firmly.

If the battery e.m.f. tends to overcome that of the dynamo, the current will cease, and *D* will be withdrawn from the mercury cups before a reverse current has time to flow.

¶ 6. Small Rectifier Plants

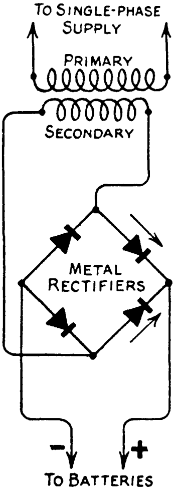


FIG. 44. SINGLE-PHASE FULL-WAVE METAL RECTIFIER FOR BATTERY CHARGING (*Westinghouse*)

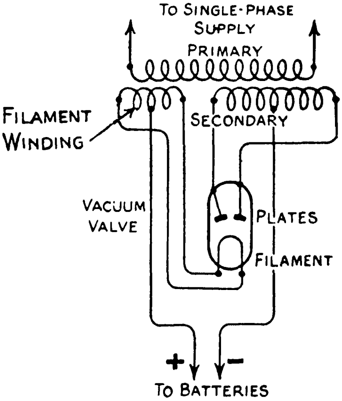


FIG. 45. SINGLE-PHASE FULL-WAVE VALVE RECTIFIER FOR BATTERY CHARGING (*Westinghouse*)

Both types are frequently used in battery charging stations, their great advantage being that they can be left unattended. Metal types are also used to supply oil-switch and other trip circuits.

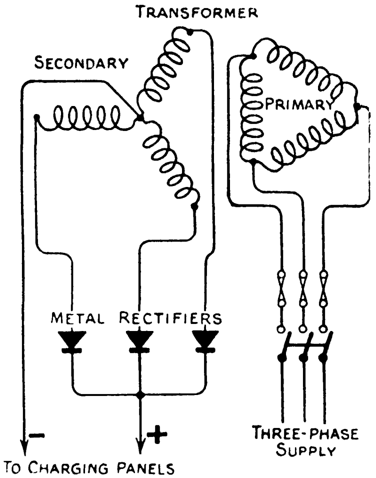


FIG. 46. THREE-PHASE HALF-WAVE METAL RECTIFIER

(Westinghouse)

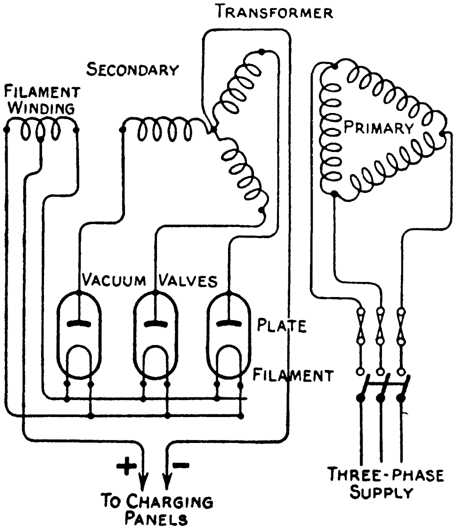


FIG. 47. THREE-PHASE HALF-WAVE VALVE RECTIFIER

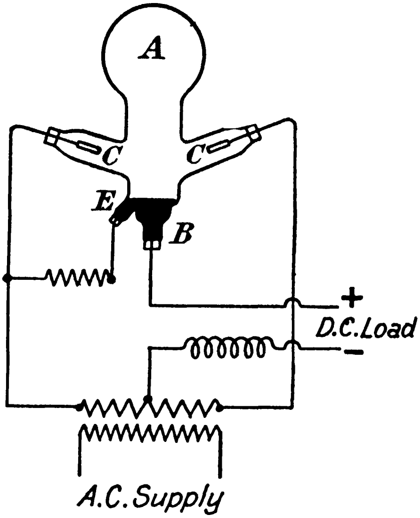


FIG. 48. MERCURY ARC RECTIFIER

SECTION III

FILAMENT-LAMP CIRCUITS

The term "plug-connection" is used instead of "wall plug," "wall-socket," etc.

¶ 1. Method of Representing Switches, etc., in Diagrams

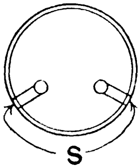


FIG. 49. METHOD OF ILLUSTRATING A TWO-PIN PLUG CONNECTION

S, Sockets for plug.

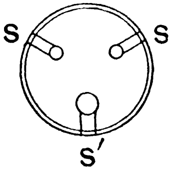


FIG. 50. METHOD OF ILLUSTRATING A THREE-PIN PLUG CONNECTION

S, *S*, *S′*, Sockets for plug.

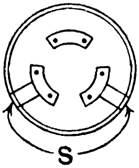


FIG. 51. METHOD OF ILLUSTRATING A COMBINED THREE PLATE CEILING ROSE AND TWO PIN PLUG CONNECTION

S, Sockets for plug.

The abbreviation "Rose-Plug" is sometimes used for this.

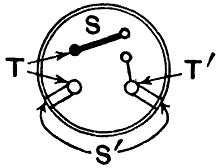


FIG. 52. METHOD OF ILLUSTRATING A COMBINED SWITCH AND TWO-PIN PLUG CONNECTION

S, switch; *S′*, sockets for plug; *T*, *T′*, terminals.
The abbreviation "Switch-Plug" is sometimes used for this.

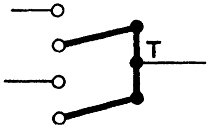


FIG. 53. METHOD OF ILLUSTRATING A DOUBLE OR TWINOB SWITCH

T, common terminal.

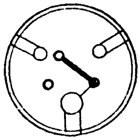


FIG. 54. METHOD OF ILLUSTRATING A COMBINED SWITCH AND THREE-PIN PLUG CONNECTION

The abbreviation "Three-Pin Switch-Plug" is sometimes used for this.

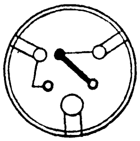


FIG. 55. METHOD OF ILLUSTRATING A COMBINED TWO-WAY SWITCH AND THREE-PIN PLUG CONNECTION

The abbreviation "Two-Way Switch-Plug" is sometimes used for this.

¶ 2. Simple Switch Circuits

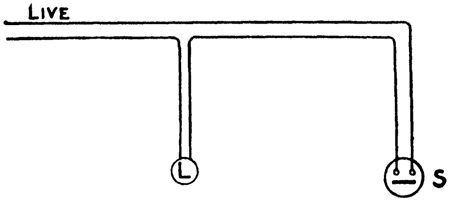


FIG. 56. ONE LAMP CONTROLLED BY ONE SWITCH

L, Lamp; *S*, Switch.

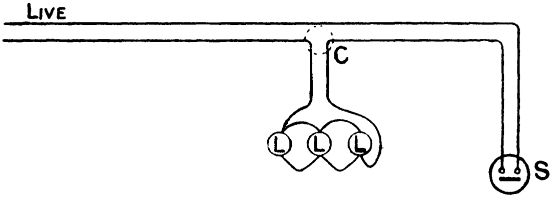


FIG. 57. THREE LAMPS IN PARALLEL CONTROLLED BY ONE SWITCH; WITH OR WITHOUT CEILING ROSE

L, *L*, Lamps; *S*, Switch; *C*, Ceiling Rose.

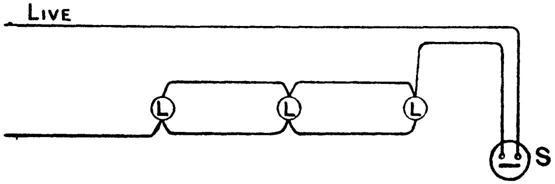


FIG. 58. THREE LAMPS ON DIFFERENT FITTINGS, CONNECTED IN PARALLEL TO ONE SWITCH

L, *L*, Lamps; *S*, Switch.

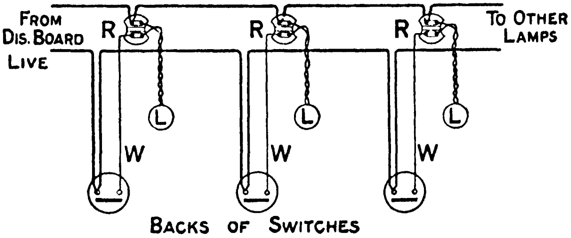


FIG. 59. POSITIVE LEAD LOOPED INTO SWITCHES, NEGATIVE LEAD INTO ROSES; SEPARATE WIRES BETWEEN EACH SWITCH AND ROSE

R, Ceiling roses.
L, Lamps, each separately controlled by a switch.
W, separate wires between switches and roses.

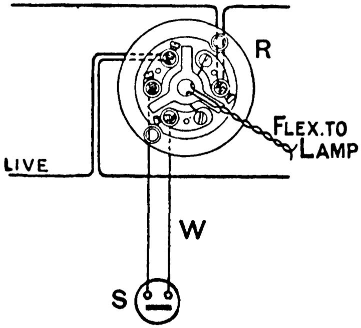


FIG. 60. POSITIVE AND NEGATIVE LEADS LOOPED INTO ROSE

The rose *R* has three plates to provide for flex to lamp and separate wires *W* to switch *S*.

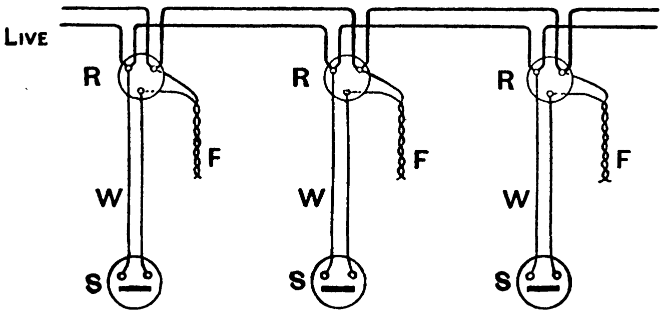


FIG. 61. POSITIVE AND NEGATIVE LEADS LOOPED INTO THREE ROSES WITH SEPARATE WIRES TO SWITCHES

F, flex to lamps.
R, roses.
S, switches.
W, wires.

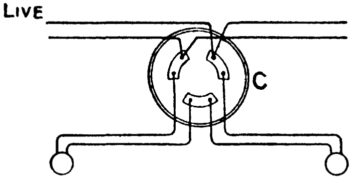


FIG. 62. CONNECTION OF TWO LAMPS IN SERIES TO THREE PLATE ROSE

C, rose.

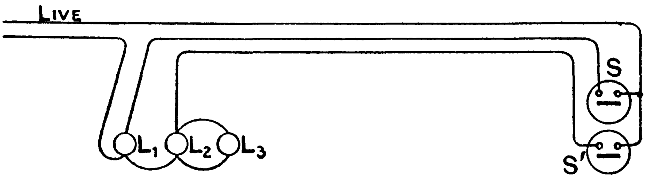


FIG. 63. CONNECTION OF THREE LAMPS TO TWO SWITCHES

Switch *S* controls lamp L_1, switch *S′* controls lamps L_2 and L_3.

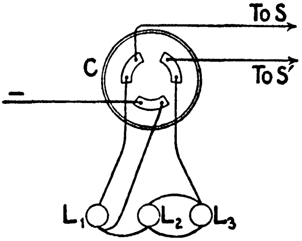


FIG. 64. THE SWITCHES AND LAMPS IN FIG. 63 CONNECTED THROUGH A THREE PLATE ROSE

C, rose.
L_1, L_2, L_3, lamps.

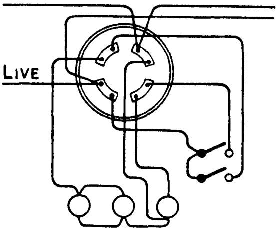


FIG. 65. THE SWITCHES AND LAMPS IN FIG. 63 CONNECTED THROUGH A FOUR-PLATE ROSE WITH BOTH CIRCUIT POLES LOOPED INTO IT

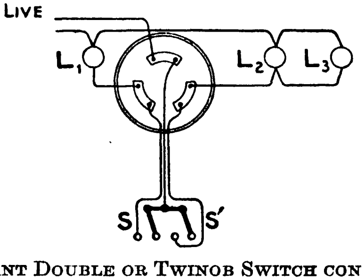


FIG. 66. A PENDANT DOUBLE OR TWINOB SWITCH CONNECTED THROUGH A THREE PLATE ROSE TO THREE LAMPS

S controls L_1, *S′* controls L_2 and L_3.

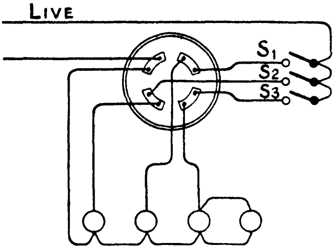


FIG. 67. THREE SWITCHES CONNECTED TO FOUR LAMPS THROUGH A THREE PLATE ROSE

S_1 and S_2 each control one lamp; S_3 controls two lamps.

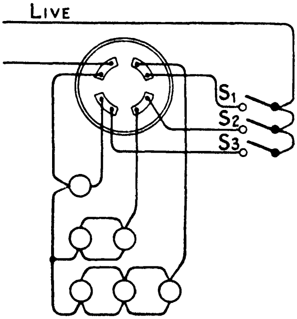


FIG. 68. THREE SWITCHES CONNECTED TO SIX LAMPS THROUGH A FOUR PLATE ROSE

S_1, S_2, and S_3 switches, respectively controlling three, two, and one lamps.

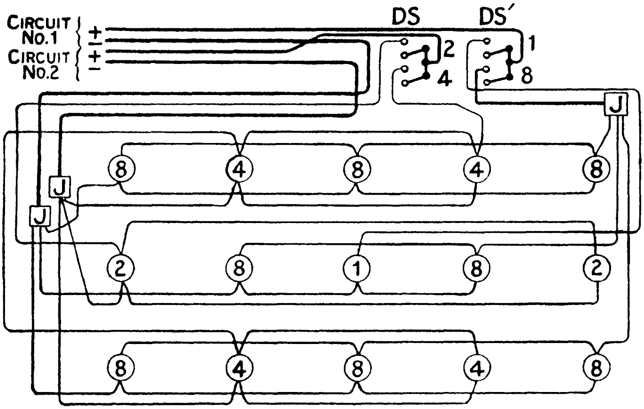


Fig. 69. Example of control by Two Double or Twinob Switches (or Four Single Switches) of Fifteen Lamps or Groups of Lamps pendent from the Ceiling of a Large Room

DS, *DS′*, double switches.

The numbers in the lamp circles correspond with the numbered switches which control them. Thus when switch No. 1 is on, only the lamp (or group) in the centre of the ceiling is lighted. When switch No. 8 is closed, the corresponding eight lamps or groups are lighted. Whichever switch or switches are on, the lighting is symmetrical. *J*, *J*, *J* are junction boxes, and the wiring is distributed between two distribution board circuits, as shown both in Fig. 69 and Fig. 70.

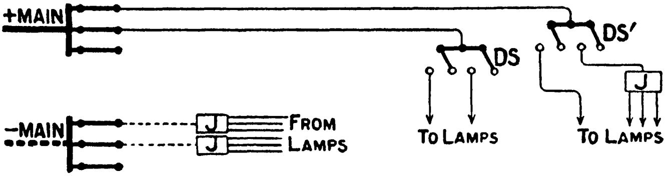


Fig. 70. Distribution Board Circuits of Fig. 69

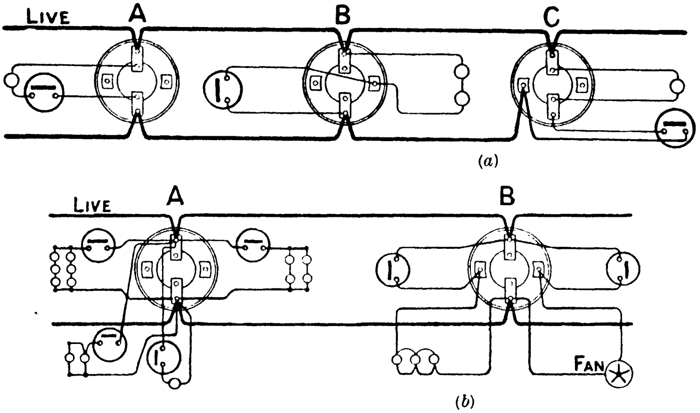


FIG. 71. VARIOUS USES OF THE EDISWAN COMBINED FOUR PLATE CONNECTING-BOX AND TWO-PIN PLUG CONNECTION

In (*a*) at *A*, a simple lamp and switch circuit is joined-up through the plug connection; at *B*, separate leads are taken to the lamps and to the switch; at *C*, there are also separate leads, the lamp being joined-up through the plug connection. In (*b*) at *A*, four lamp and switch circuits are connected; at *B*, a lamp and a fan circuit are connected, their respective switches being on separate leads.

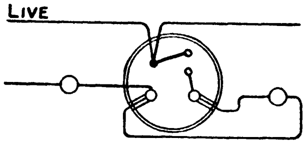


FIG. 72. TWO LAMPS IN SERIES CONTROLLED BY A SWITCH-PLUG

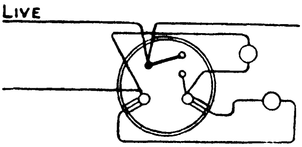


FIG. 73. TWO LAMPS IN PARALLEL CONTROLLED BY A SWITCH-PLUG

In both cases one of the lamps is connected through the plug of the combined switch and plug-connection or "switch-plug."

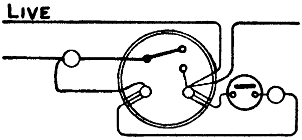


Fig. 74. Use of Switch-plug

Plug-connected lamp controlled by its own switch. Separate lamp controlled by switch of switch-plug.

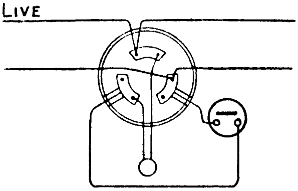


Fig. 75. Use of Rose-plug

Pendant lamp controlled by plug-connected switch.

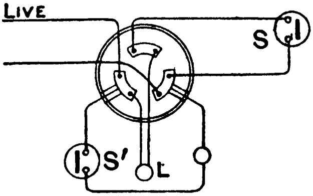


Fig. 76. Use of Rose-plug

Pendant lamp *L* controlled by fixed switch *S*. Lamp and switch *S′* in plug circuit.

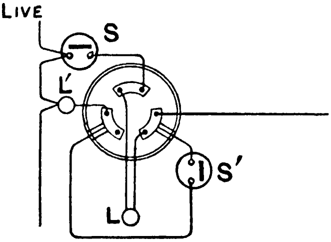


Fig. 77. Use of Rose-plug

Pendant lamp *L* controlled by fixed switch *S*; fixed lamp *L′* controlled by plug-connected switch *S′*.

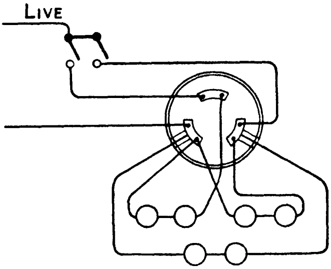


FIG. 78. USE OF ROSE-PLUG

Pendant and plug-connected lamps controlled by fixed double switch.

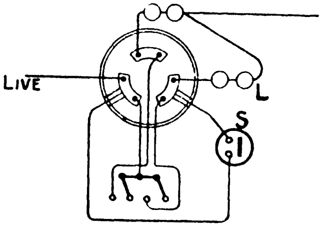


FIG. 79. USE OF ROSE-PLUG

Pendant double switch controls two fixed lamp-groups. Group *L* is also controlled by plug-connected switch *S* if corresponding half of double switch be "off."

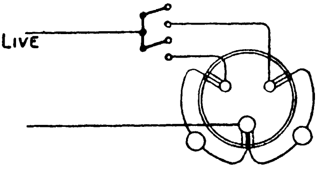


FIG. 80. USE OF THREE-PIN PLUG CONNECTION

Two pendant lamps controlled by fixed double switch.

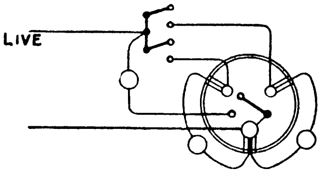


FIG. 81. USE OF THREE-PIN SWITCH-PLUG

Two lamps in plug circuit controlled by fixed double switch. Fixed lamp controlled by switch of switch plug.

¶ 3. Two-way and Intermediate Switch Circuits

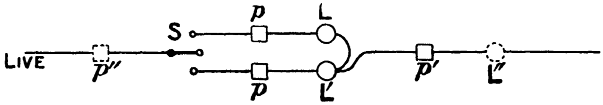


Fig. 82. Two-way Off-switch connected to Two Lamps

L, *L'*, lamps; *S*, switch.

If lamps are suspended from a rose, the plates of latter are indicated by *p*, *p*, *p'*; if the switch is so suspended, the plates of the rose are indicated by *p*, *p*, *p''*. The lamp *L''*, if fitted, is in series with *L* or *L'*.

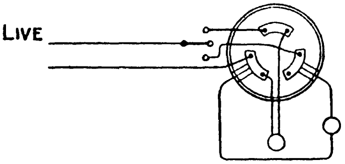


Fig. 83. Two-way Off-switch connected to Two Lamps

One lamp is suspended from, and the other plug-connected to, the rose-plug.

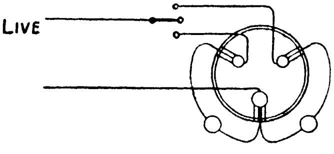


Fig. 84. Two-way Off-switch connected to Two Lamps

Lamps connected through three-pin plug-connection.

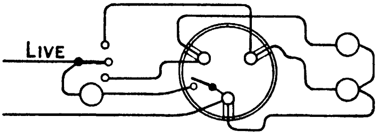


FIG. 85. TWO-WAY OFF-SWITCH AND THREE-PIN SWITCH-PLUG CONTROLLING THREE LAMPS

Lamps controlled by two-way off switch are in the plugged circuit. The third lamp is fixed, and is controlled by switch of 3-pin switch-plug.

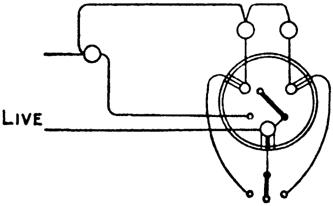


FIG. 86. PLUG-CONNECTED TWO-WAY OFF-SWITCH AND THREE-PIN SWITCH-PLUG CONTROLLING THREE FIXED LAMPS

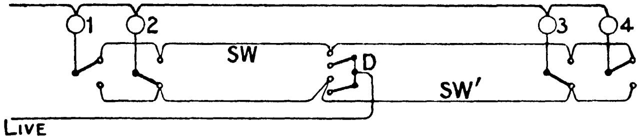


FIG. 87. MASTER-SWITCH CIRCUIT. SEPARATE LAMPS CONTROLLED BY SEPARATE TWO-WAY SWITCHES AND ONE MASTER DOUBLE SWITCH

D, master double switch.

If *D* is off, all lamps are off and none can be lighted. If either half of *D* is put on, any lamp may be lighted or extinguished at its own switch. If both halves of *D* are put on, all the lamps will be lighted irrespectively of the positions of the other switches. *SW* and *SW′* are the strapping wires, and any number of lamp-and-switch groups, as 1, 2, 3, and 4, may be connected thereto.

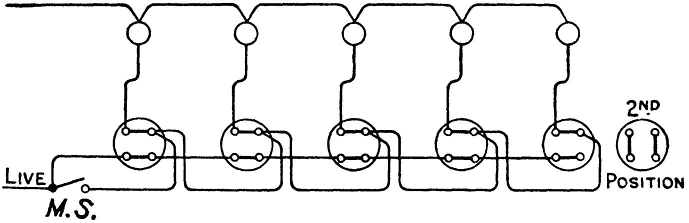


FIG. 88. MASTER-SWITCH CIRCUIT. ANY NUMBER OF LAMPS, EACH CONTROLLED BY A SEPARATE INTERMEDIATE SWITCH

The whole lighted and kept alight by the master-switch *MS*.

Other Master-Switch Circuits will be found in Figs. 100, 104 105, 106, 109, 110, 140, and 141.

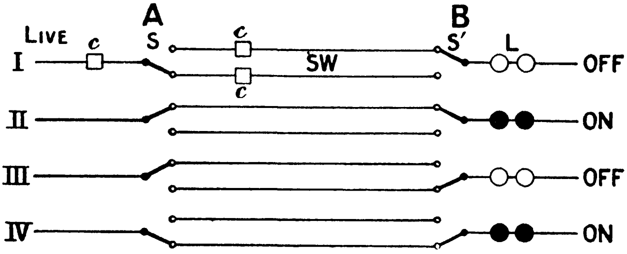


FIG. 89. TWO-WAY CIRCUIT

Two-way switch *S* at a point *A* and similar switch *S′* at a point *B* control a lamp or lamps *L*. *SW* are the strapping wires. If one of the switches, say *S*, is to be suspended, *c c c* are the plates of the rose. The figure shows the four different conditions of the circuit.

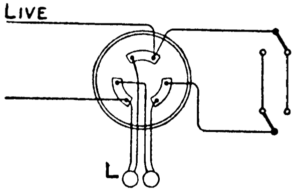


FIG. 90. TWO-WAY CIRCUIT

Switches control one of two lamps suspended from a three-plate rose.

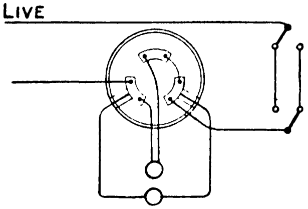


FIG. 91. TWO-WAY CIRCUIT

Switches control two lamps in parallel, one suspended from, and the other plug-connected to, a rose-plug.

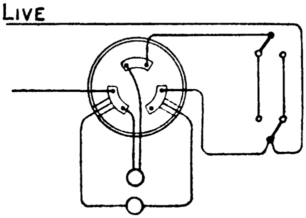


FIG. 92. TWO-WAY CIRCUIT

Similar to Fig. 92, except that the plugged lamp is independent.

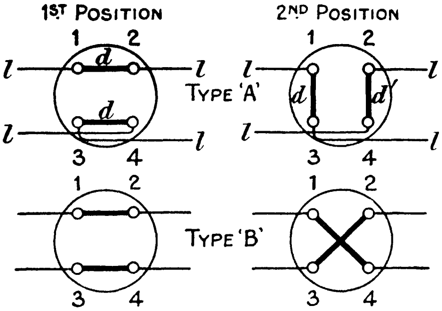


FIG. 93. METHOD OF ILLUSTRATING THE TWO POSITIONS OF AN ORDINARY INTERMEDIATE SWITCH

The terminals and fixed contacts are indicated by 1, 2, 3, 4; the moving contacts by *d* and *d′*; and the strapping wires by *l*, *l*, *l*, *l*.

N.B. Symbols for Special Switches, *viz.* the *Whole-or-Part Circuit*, the *Parallel-or-Series*, the *Marvel*, and the *Marvel Intermediate*, are given in Figs. 114, 117, 118 and 132 respectively.

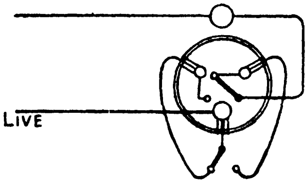


FIG. 94. TWO-WAY CIRCUIT

One switch combined with a three-pin plug-connection, the other in the plugged circuit.

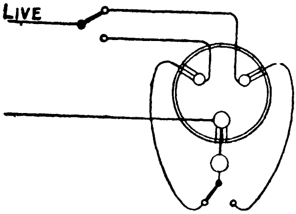


FIG. 95. TWO-WAY CIRCUIT

One switch and the lamp connected through a three-pin plug-connection.

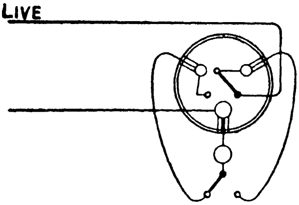


FIG. 96. TWO-WAY CIRCUIT

Similar to Fig. 95, except that the second switch is combined with the plug-connection.

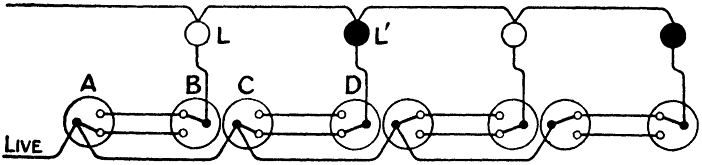


FIG. 97. SERIES OF TWO-WAY CIRCUITS

Assume lamps and switches are fitted in a corridor for example. *L* may be turned on at *A* and off at *B*, *L′* on at *C* and off at *D*, and so on.

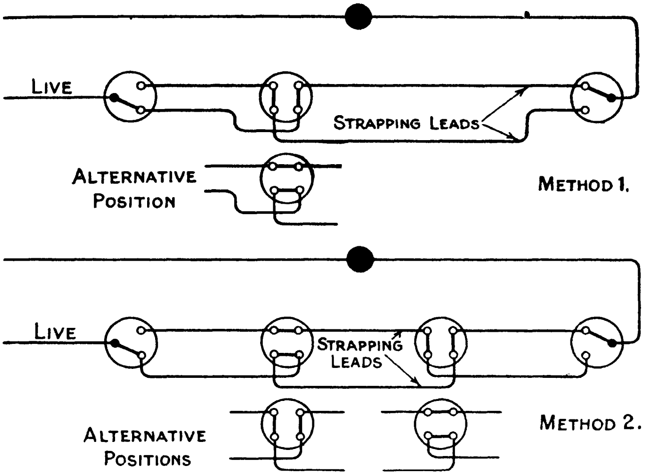


FIG. 98. TWO-WAY AND INTERMEDIATE SWITCHING SYSTEMS

Corridor switching.

Method 1. Diagram shows the connections required to control a lamp from three positions when using "Crabtree" intermediate switches.
Method 2. Shows modification of the circuit when more than three points of control are required.

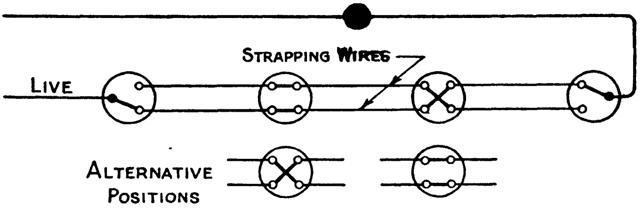


FIG. 99. TWO-WAY AND INTERMEDIATE SWITCH CIRCUIT

Diagram of circuit for corridor multiple-point control using "Tucker" switches, the internal connections of which are different to the "Crabtree" switch. Note the alterations in the strapping lead connections.

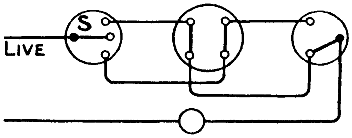


FIG. 100. MASTER-SWITCH CIRCUIT. TWO-WAY AND INTERMEDIATE CIRCUIT

If one of the end switches be "two-way and off" as at *S*, the circuit may be rendered inoperative when desired.

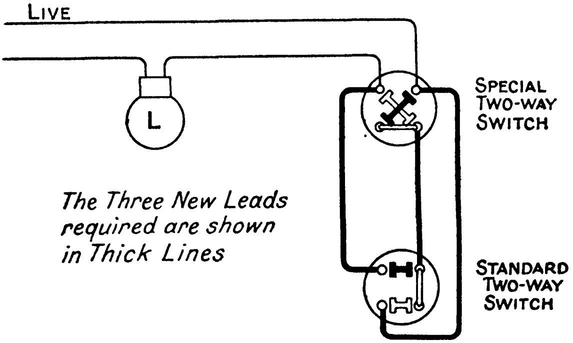


FIG. 101. METHOD OF CONVERTING SINGLE SWITCH-POINT TO TWO-WAY SWITCHING (*J. A. Crabtree & Co.*)

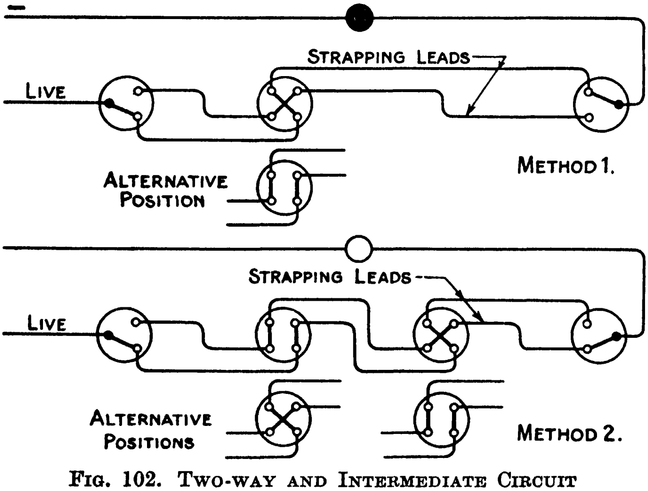


FIG. 102. TWO-WAY AND INTERMEDIATE CIRCUIT

Diagram showing the connections required for multiple-point control using switches of another type. Note strapping wire connections.

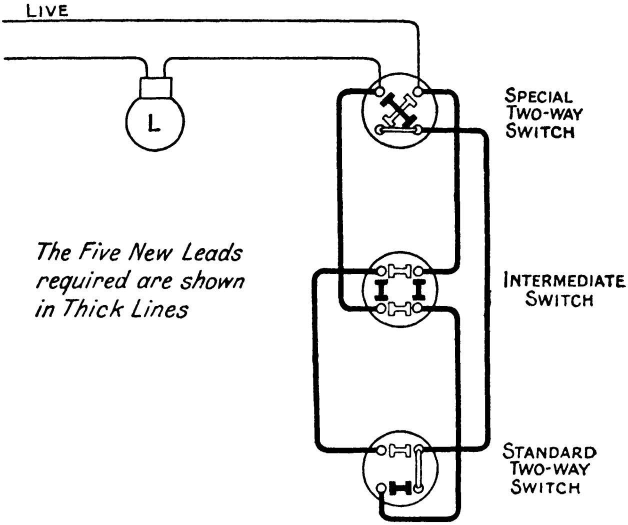


FIG. 103. METHOD OF CONVERTING SINGLE SWITCH-POINT TO TWO-WAY AND INTERMEDIATE SWITCHING

(*Crabtree*)

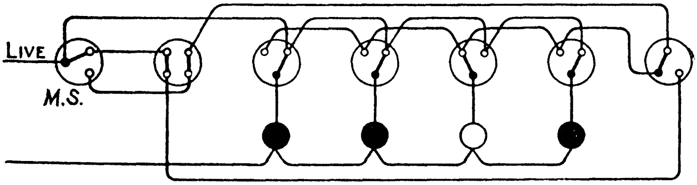


FIG. 104. MASTER-SWITCH CIRCUIT. TWO-WAY AND INTERMEDIATE CIRCUIT, WITH EACH LAMP SEPARATELY CONTROLLED BY A MASTER-SWITCH M.S.

Each lamp is connected through a separate two-way switch, which, in one position, lights the lamps irrespectively of the condition of the two-way and intermediate circuit. When the switch is in the other position, the lamp is restored to the two-way and intermediate circuit.

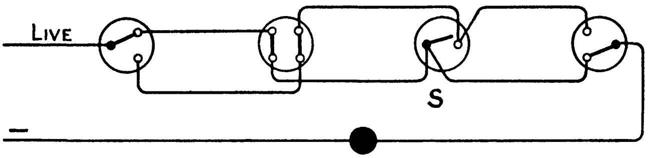


FIG. 105. MASTER-SWITCH CIRCUIT. TWO-WAY AND INTERMEDIATE CIRCUIT

When the master-switch *S* is "on," the lamps will be lighted or kept alight without being affected by the other switches.

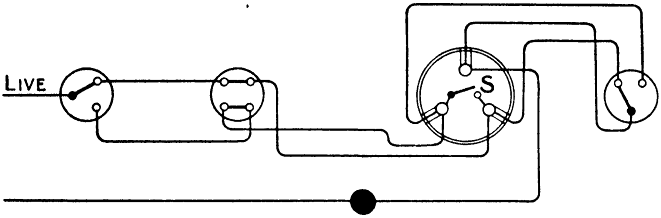


FIG. 106. MASTER-SWITCH CIRCUIT

Similar to Fig. 105, except that the master-switch *S* forms part of a three-pin switch plug to which one of the two-way switches is plug-connected.

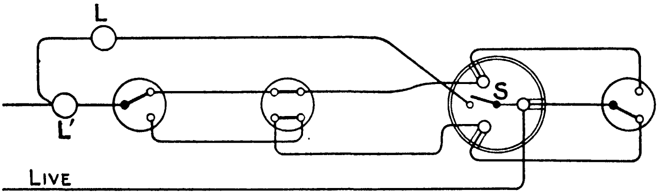


FIG. 107. TWO-WAY AND INTERMEDIATE CIRCUIT

One of the two-way switches is connected to a three-pin switch-plug; and the circuit controls the lamp *L′*. The lamp *L* is independantly controlled by the switch *S* of the switch-plug.

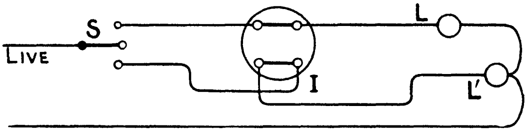


FIG. 108. INTERMEDIATE SWITCH USED AS A DIVERTING SWITCH

Either *L* or *L'* may be lighted at the "two-way and off" switch *S*. With either lamp (say *L*) alight, the current may be turned over to the other (say *L'*) by means of *L*.

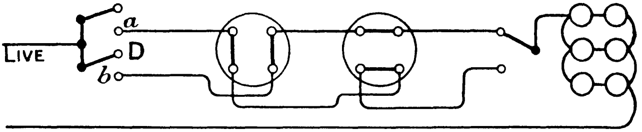


FIG. 109. MASTER-SWITCH CIRCUIT. SEMI TWO-WAY AND INTERMEDIATE CIRCUIT

With both halves *a* and *b* of the double switch *D* "off," the circuit is dead. With either half *a* or *b* "on," the lamps may be turned on or off at the other switches. With both halves "on," the lamps will be lighted and will be unaffected by the other switches.

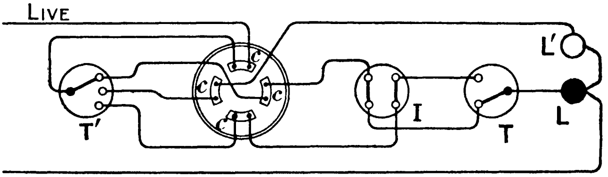


FIG. 110. SEMI TWO-WAY AND INTERMEDIATE CIRCUIT

If the three-way switch *T'* is on either its top or bottom contact, it is working in the circuit comprising the intermediate switch *I*, the two-way switch *T*, and the lamp *L*. If *T'* is on its middle contact, *L'* will be lighted, and the other circuit rendered dead. If *T'* is to be a pendant switch, a four-plate rose *c*, *c*, *c*, *c* will be necessary.

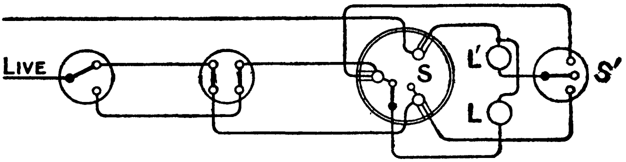


FIG. 111. TWO-WAY AND INTERMEDIATE CIRCUIT

The lamp *L* and two-way switch *S′* (forming part of the two-way and intermediate circuit) are plug-connected to a two-way switch-plug, the switch *S* of which controls a separate and independent lamp *L′*.

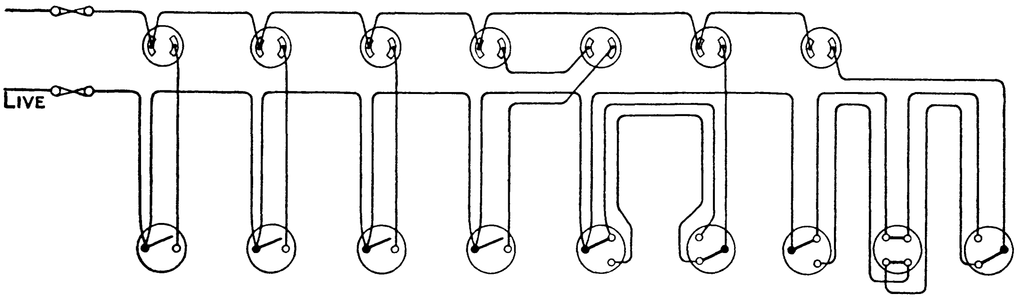


FIG. 112. TYPICAL SEVEN-POINT SUB-CIRCUIT

The circuit shown comprises lamps as follows: 3 single points; 2 points in series controlled by a switch; 1 point controlled by 2-way switching; 1 point controlled by 2-way and intermediate switching.

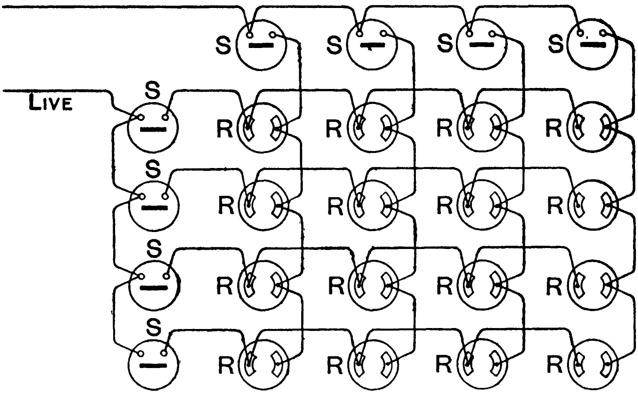


FIG. 113. AN EXPERIMENTAL CIRCUIT CONTAINING EIGHT SWITCHES AND SIXTEEN LAMPS

R, Roses. *S*, Switches.

This circuit gives control of any one lamp by operating one switch in each bank. After the first operation of switches it will be found that one extra lamp will light with each switch movement in any bank of switches. If all switches are closed, then sixteen lamps will be controlled by eight switches.

¶ 4. Whole-or-part-circuit and Parallel-or-series Switches

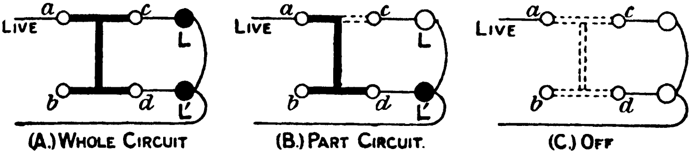


FIG. 114. WHOLE-OR-PART-CIRCUIT SWITCH
(*Lundberg*)

This tumbler switch has three positions and four terminals which are represented by *a*, *b*, *c*, *d*.

In position (*A*) the four terminals are interconnected, and the whole circuit (in this case *L* and *L′*) is on.

In position (*B*) three of the terminals are interconnected, and part of the circuit (in this case *L′*) is on.

In position (*C*) the current is off.

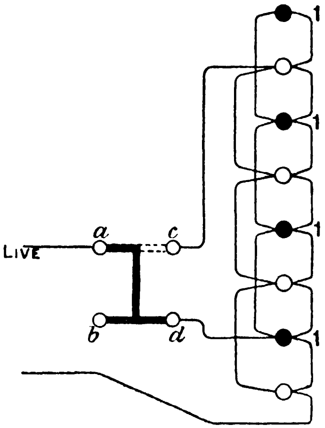


FIG. 115. WHOLE-OR-PART-CIRCUIT SWITCH CIRCUIT

The figure shows the switch connected to a group of eight lights, and in the "part" position with half of the lights on.

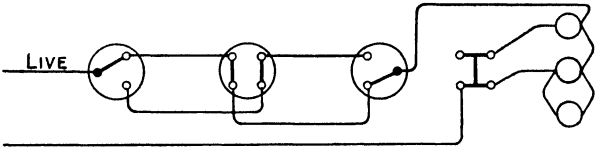


FIG. 116. WHOLE-OR-PART-CIRCUIT SWITCH, COMBINED WITH A TWO-WAY AND INTERMEDIATE CIRCUIT

In this case, the whole-or-part switch should not have an off position. The makers can arrange for this.

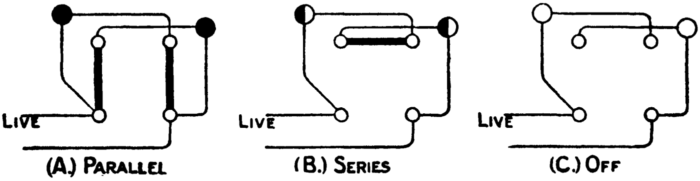


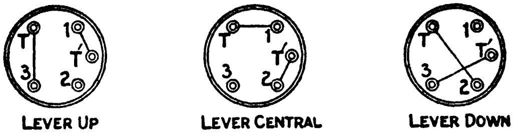
FIG. 117. PARALLEL-OR-SERIES SWITCH
(*Lundberg*)

This tumbler switch has three positions and four terminals, and is chiefly used for putting lamps either in parallel or series. When in series the lamps give a dim light.

Note. Various uses of the above switches are given in Figs. 148, 150, 151, 158 and 173.

¶ 5. The Marvel Switch

5A. Ordinary Type



LEVER UP LEVER CENTRAL LEVER DOWN

Fig. 118. The Marvel Switch
(*Lundberg*)

This tumbler switch have five terminals, and the diagram shows their interconnection in the three different positions of the "dolly" or lever.

Terminals 1, 2, and 3 are the strapping or coupling terminals, and *T* and *T′* the lamp circuit terminals.

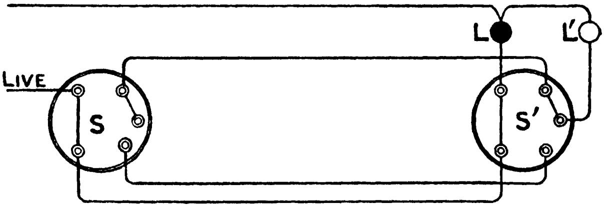


Fig. 119. Two Coupled Marvel Switches connected to Two Lamps, so that either of the latter may be Lighted from either Switch

5B. ACTION

As already mentioned, there are three positions for the lever of the Marvel switch, but which position of one switch will give a certain effect depends entirely on the position of the other switch when there are two coupled together, as will be seen in Figs. 119–130, 134, 135–154.

There are, in fact, nine different relative positions of the two switches, and though this may sound rather complicated, the matter resolves itself in practice to moving a switch either once or twice to get the desired result. It follows, therefore, that the switches could not be connected to lamps out of sight, for one would never know what effect had been produced. It is seldom, however, that lamps cannot be seen from their switch points.

The nine relative positions of the switches, and the effects on the lamps in Fig. 119, are given in that and the following eight diagrams:

FIRST POSITION. *S* and *S′* both up.—Referring to Fig. 119, the internal switch-connections are there shown as they would be if both levers were in their uppermost positions (see Fig. 118), and under these conditions *L* would be "on," *i.e.*, alight. The other eight positions are shown in Figs. 120–127.

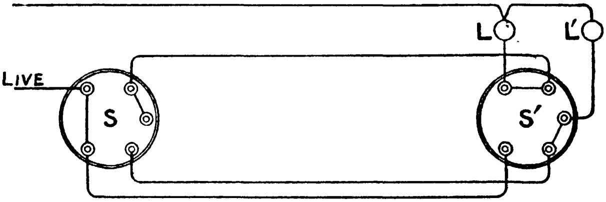


FIG. 120. SECOND POSITION

S up, *S′* central. Current "off."

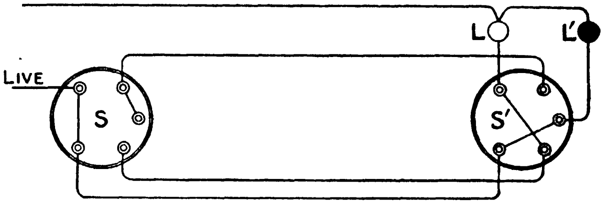


Fig. 121. Third Position

S up, *S′* down, *L′* "on."

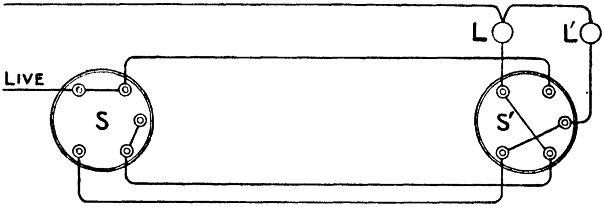


Fig. 122. Fourth Position

S central, *S′* down. Current "off."

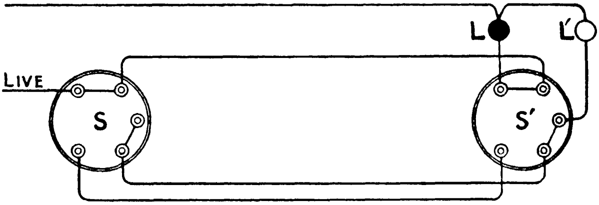


Fig. 123. Fifth Position

S central, *S′* central, *L* "on."

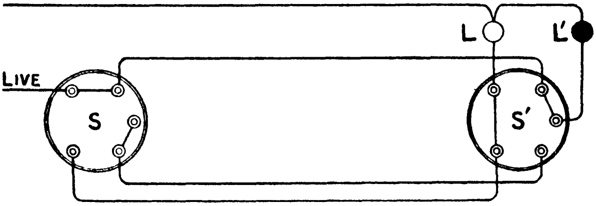


Fig. 124. Sixth Position

S central, *S′* up, *L′* "on."

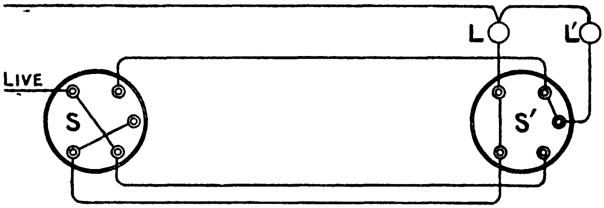


FIG. 125. SEVENTH POSITION

S down, *S′* up. Current "off."

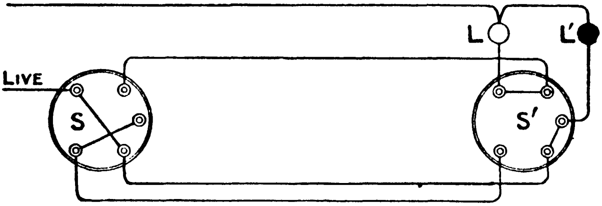


FIG. 126. EIGHTH POSITION

S down, *S′* central, *L′* "on."

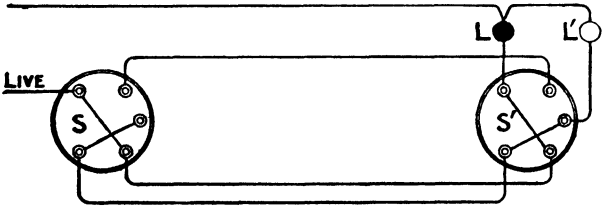


FIG. 127. NINTH POSITION

Both down, *L* "on."

5c. Other Circuits for the Ordinary Type

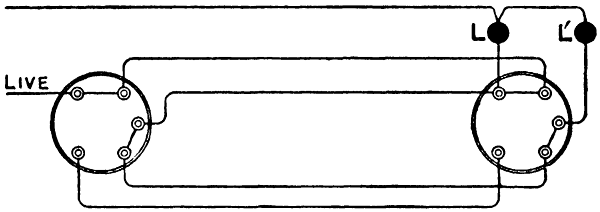


Fig. 128

Either switch will effect the following changes: *L′* alone, *L′* and *L* in parallel, current off.

The *internal* changes in the switch connections, in the various relative positions of the two switch levers, are similar to those in Figs. 119 to 127.

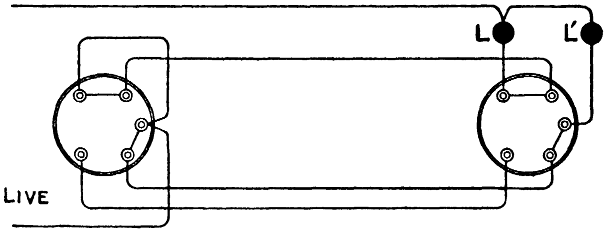


Fig. 129

Either switch will effect the following changes: *L* alone, *L′* alone, and *L* and *L′* in parallel.

There is no off position, so that a separate one-way switch must be used for this purpose.

The *internal* changes in the switch connections, in the various relative positions of the two switch levers, are similar to those in Figs. 119 to 127.

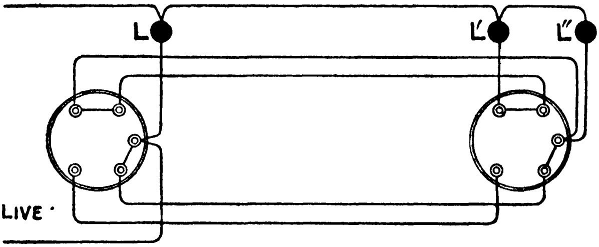


FIG. 130

Either switch will effect the following changes: *L* alone, *L* and *L′* in parallel, *L*, *L′*, and *L″* in parallel.

There is no "off" position, so that a separate one-way switch must be used for this purpose.

The *internal* changes in the switch connections, in the various relative positions of the two switch levers, are similar to those in Figs. 119 to 127.

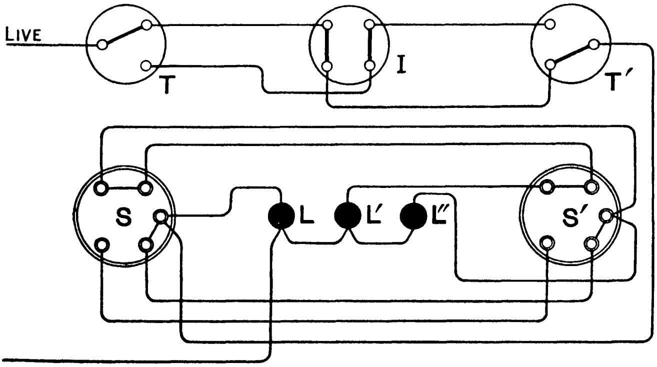


FIG. 131. ELECTROLIER OR OTHER GROUP

The circuit in Fig. 130 (with additional lamps) combined with an ordinary two-way and intermediate circuit.

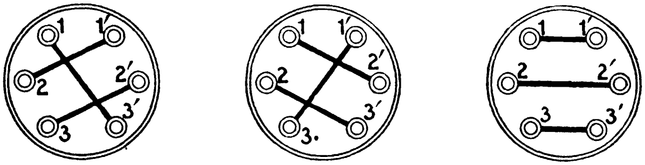
The Marvel switches *S* and *S′* simply allow of the number of lights being altered at either switch: Thus *L*, or *L* and *L′*, or *L*, *L′*, and *L″*. The current is put on or off at either *T*, *I*, or *T′*. (See also Figs. 69, 103 and 149.) For other uses see Figs. 152–154.

5D. Intermediate Type

In Figs. 119–127 and 129 the various circuit operations are controlled from two switches connected by three strapping wires. If necessary, one or more extra Marvel switches (specially modified and with six terminals) may be connected in these strapping wires to give the control from three or more points.

These *Marvel intermediate switches* are different from that modification described at the bottom of p. 72, and intended for use as an ordinary intermediate switch in a double strapping-wire circuit like Fig. 95.

The internal construction of the Marvel intermediate switch is rather more complicated than that of the ordinary type, there being no less than 18 contacts on the moving part, besides the six fixed contacts connected with the terminals. Nevertheless, the switch moves very easily and definitely into each of its three positions. The internal connections in the three positions are given in Fig. 132.



LEVER UP **LEVER CENTRAL** **LEVER DOWN**

FIG. 132. INTERCONNECTION (WITHIN THE SWITCH ITSELF) OF THE SIX TERMINALS OF THE MARVEL INTERMEDIATE SWITCH FOR TREBLE STRAPPING WIRES, IN ITS THREE POSITIONS

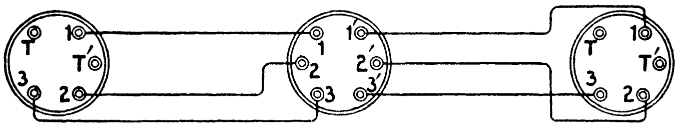


FIG. 133. INTERCONNECTION OF ONE INTERMEDIATE AND TWO ORDINARY MARVEL SWITCHES

As the positions of the respective terminals are numbered on the back of each switch base, the connection of a Marvel intermediate switch to two ordinary Marvel switches is simplified, as may be gathered from Fig. 127.

When two or more intermediate switches are included in a circuit, it is necessary that the terminals 1, 2, and 3 on one intermediate switch should be joined up to the terminals 1′, 2′, and 3′ respectively on the other. This is illustrated in Fig. 134, which shows two intermediate and two ordinary Marvel switches interconnected.

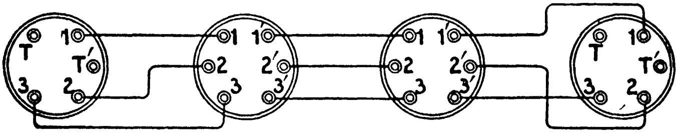


FIG. 134. INTERCONNECTION OF TWO INTERMEDIATE AND TWO ORDINARY MARVEL SWITCHES

5E. SPECIAL USES AND MODIFICATIONS

SELECTING SWITCH. When an ordinary Marvel switch is connected to three lamps (or other devices) *A*, *B*, and *C*, as in Fig. 135, either *A* and *B*, *B* and *C*, or *A* and *C* may be put in circuit, as illustrated.

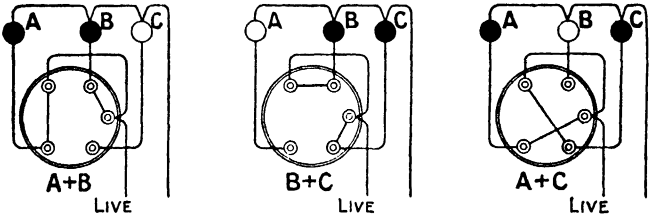


FIG. 135. MARVEL SWITCH SO CONNECTED TO THREE LAMPS (OR OTHER DEVICES) *A*, *B*, AND *C*, THAT EITHER *A* AND *B*, *B* AND *C*, OR *A* AND *C* MAY BE PUT IN CIRCUIT

There is no "off" position, so that a one-way switch must be connected somewhere in the circuit for putting the current on or off.

INTERMEDIATE SWITCH FOR DOUBLE STRAPPING WIRES, WITH "OFF" POSITION. The ordinary intermediate switch (Fig. 56) does not break the circuit within itself; but merely alters the connection of the strapping wires on each side of it. The Marvel switch, however, may be adapted to work (in conjunction with two-way switches) as an intermediate switch with off or break-circuit position. It can therefore act as a master-switch to prevent the use of the current at *any* point in the circuit, not at one end only, as with the two-way off-switch in Fig. 100. The internal connections of the Marvel switch, as modified for the above purpose, are shown in Fig. 136, where *S*, *S* are the strapping wires. It will be noticed that the internal-connection changes are different from those of the standard pattern as given in Fig. 118, and that one terminal and contact are unused.

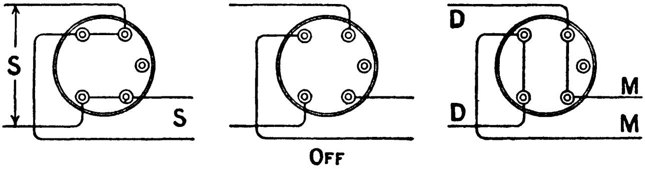


FIG. 136. INTERNAL CONNECTION CHANGES OF MARVEL SWITCH WHEN MODIFIED TO ACT AS AN INTERMEDIATE-AND-OFF SWITCH

(See bottom of p. 83.)

THREE-WAY Switch (Fig. 137). For this use the standard arrangements of the contacts is employed, but the terminal marked T' in Fig. 118 is unused. According to the position of the switch, the "live" lead is connected to circuits 1, 2, or 3 in Fig. 137.

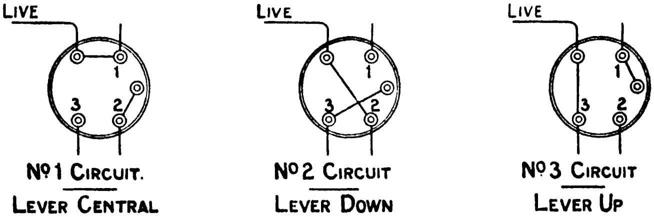


FIG. 137. INTERNAL CONNECTION CHANGES OF MARVEL SWITCH WHEN CONNECTED TO ACT AS A THREE-WAY SWITCH

TWO-WAY AND OFF SWITCH. It will be clear that if, in Fig. 137, No. 3 circuit be disconnected, the switch will act as a two-way and off switch. In this capacity it possesses a slight advantage over the ordinary switch of this description, in that in the "off" position the switch lever is "up" instead of "central." The "off" position may, however, be made to correspond with "lever central" if desired, by disconnecting No. 1 instead of No. 3 circuit in Fig. 137.

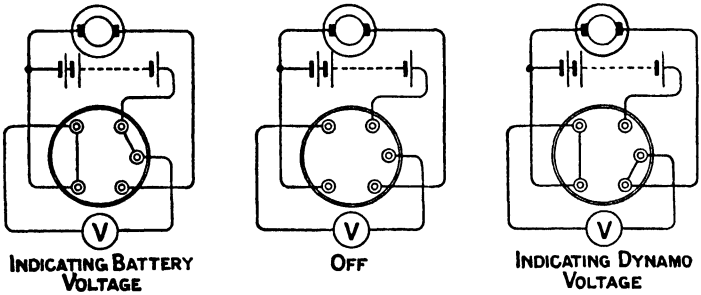


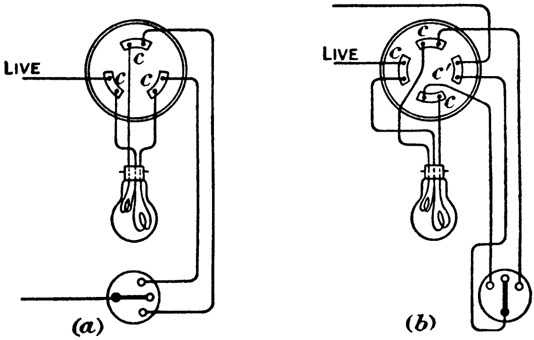
FIG. 138. INTERNAL CONNECTION CHANGES OF MARVEL SWITCH WHEN MODIFIED TO ACT AS A TWO-WAY VOLTMETER SWITCH WITH "OFF" POSITION

VOLTMETER KEY SWITCH. For this purpose the switch or rather key-switch, for it is more of a key than a switch, has two momentary "on" positions, and an "off" position. That is to say, it flies back to off as soon as released. In this capacity all five terminals are used, the voltmeter being joined to two, and being quite disconnected at both poles when the switch is off.

Fig. 138, for example, shows the connection of a voltmeter to a dynamo and battery, so that the terminal p.d. of either may be ascertained at will. These connections, by the way, are simply the small voltmeter wires; the main leads being omitted.

REVERSING SWITCH WITH "OFF" POSITION. This modification of the Marvel Switch is described on p. 83.

¶ 6. Full-or-dim Light Circuits



(*a*) **PENDANT LAMP ONLY** (*b*) **PENDANT SWITCH**

FIG. 139. "TWO-WAY AND OFF" SWITCH CONTROLLING A DOUBLE-FILAMENT LAMP

(*a*) *c*, *c*, *c* are the plates of a three-plate rose if the lamp is to be suspended; and (*b*) *c′*, *c*, *c* ditto if the switch is to be a pendant one.

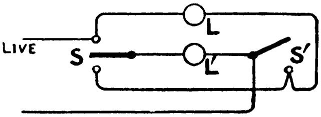


FIG. 140

Either or both of the two lamps may be run "full" or both dim. If *S* is on its upper contact, *L′* will light up. If on its lower *L* and *L′* will be in series and will burn "dim." Whatever the position of *S*, *L* is put full on when *S′* is on. If with *S* on its lower contact, *S′* is put "on," *L′* will be extinguished.

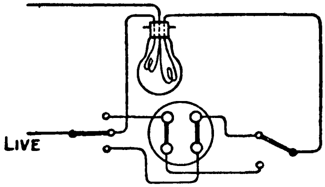


Fig. 141. Semi-two-way and Intermediate Circuit

If the three-way switch be on either its top or bottom contact, it is working in the two-way and intermediate circuit, which includes the "full" filament of the double-filament (or d.f.) lamp.

When the three-way switch is on its middle contact, the "dim" filament is lighted, and the rest of the circuit rendered dead.

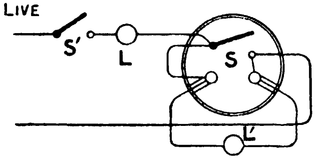


Fig. 142. Use of Switch-plug

With *S'* on and *S* "off," *L* and *L'* burn dimly.
With both *S* and *S'* on, *L* burns full and *L'* is out.

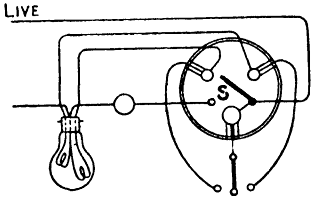


Fig. 143. Use of Three-pin Switch-plug

The "two-way and off" switch in the plug circuit lights either the long or short filament of the d.f. lamp. The switch *S* in the switch-plug controls a separate lamp.

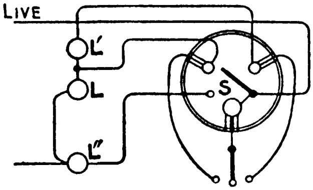


FIG. 144. USE OF THREE-PIN SWITCH-PLUG

Similar to previous example except that the d.f. lamp is replaced by the separate lamps *L* and *L′*; *L* burning alone, or *L* and *L′* in series. *L″* is the independent lamp governed by the switch *S*.

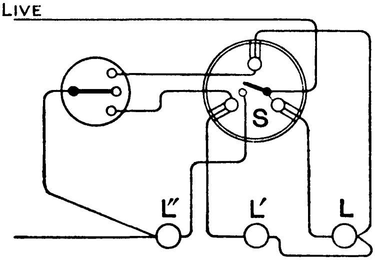


FIG. 145. USE OF THREE-PIN SWITCH-PLUG

The fixed "two-way and off" switch operates the two lamps *L* and *L′* (*L* full or both dim) in the plug circuit. The switch of the switch-plug controls a separate and independent *L″*.

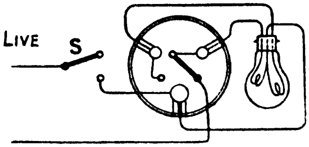


FIG. 146. USE OF TWO-WAY SWITCH-PLUG

The d.f. lamp is in the plug circuit, and either filament is lighted by the two-way switch of the switch-plug. The current is shut off at the ordinary switch *S*.

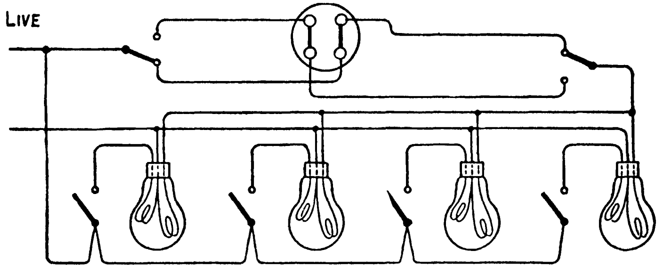


FIG. 147. TWO-WAY AND INTERMEDIATE CIRCUIT

The full filaments of all the lamps are controlled by the two-way and intermediate circuit. The "dim" filament of each lamp is controlled by an adjacent ordinary switch.

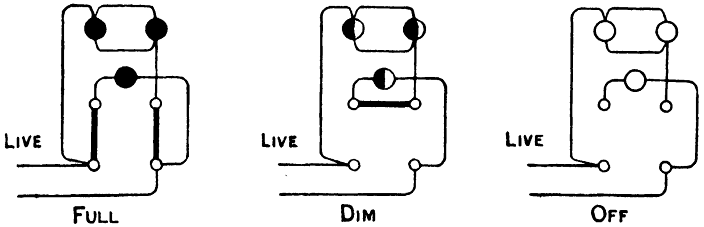


FIG. 148. USE OF PARALLEL-OR-SERIES SWITCH

Three lamps are connected, the dim light being obtained by leaving two of the lamps in parallel and putting the third in series with them.

A similar circuit, but with two lamps, was given in Fig. 115.

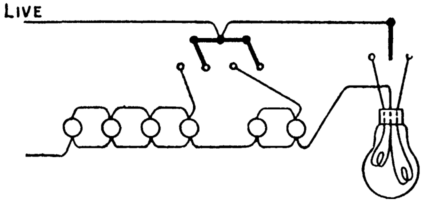


FIG. 149. ELECTROLIER OR OTHER GROUP

This arrangement, with one double and one "two-way and off" switch, gives the following gradations of light: Dim, 1, 2, 3, 4, 5, 6, or 7 lamps.

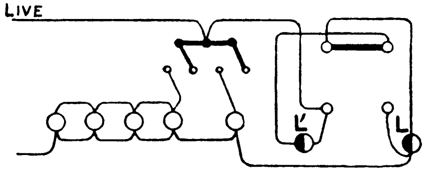


FIG. 150. ELECTROLIER OR OTHER GROUP

This arrangement, with one double and one parallel-or-series switch, gives the following gradations of light: Dim, 1, 2, 3, 4, 5, 6, or 7 lamps.

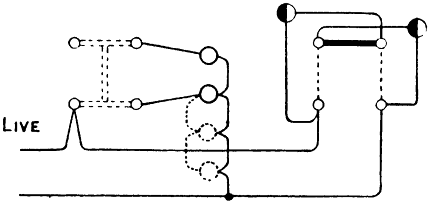


FIG. 151. ELECTROLIER OR OTHER GROUP

This arrangement, with one whole-or-part and one parallel-or-series switch, and two lamps connected to the whole-or-part switch, gives the following gradations of light: Dim, 1, 2, 3, or 4 lamps.

If the two dotted lamps are also connected to the whole-or-part switch, the gradations will be: Dim, 2, 3, 4, or 6 lamps.

N.B. Other arrangements for electrolier or group switching will be found in Fig. 131.

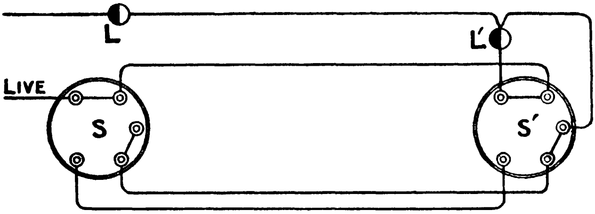


FIG. 152. USE OF MARVEL SWITCHES

The two Marvel switches *S* and *S′* enable the following circuit changes to be made at either switch: *L* alone, *L* and *L′* in series, current off.

The *internal* changes in the switch connections, in the various relative positions of the two switch levers, are similar to those in Figs. 119 to 127.

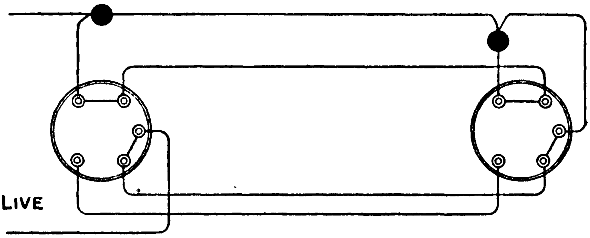


FIG. 153. USE OF MARVEL SWITCHES

The lamps may be put into parallel, or series, or off, from either switch.

The *internal* changes in the switch connections, in the various relative positions of the two switch levers are similar to those in Figs. 119 to 127.

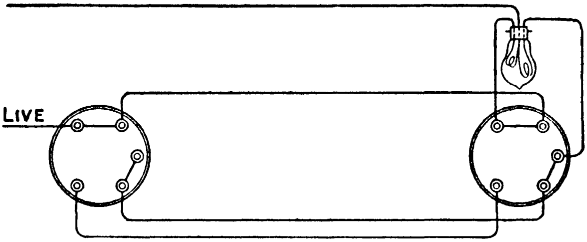


FIG. 154. USE OF MARVEL SWITCHES

Either filament of the d.f. lamp may be lighted from either switch.

The *internal* changes in the switch connections, in the various relative positions of the two switch levers, are similar to those in Figs. 119 to 127.

¶ 7. Earthing of Plug-connected Fitting

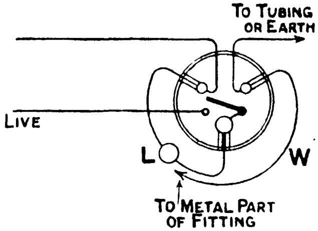


FIG. 155. EARTHING OF METAL PARTS OF PLUG-CONNECTED FITTING

This may be effected by means of a three-pin switch-plug. One of the sockets is connected to earth through the tubing or sheathing enclosing the wiring, or otherwise. The corresponding pin of the plug is connected through the wire *W* (forming the third conductor of the triple-conductor flexible) with the metal part of the fitting carrying the lamp *L*.

¶ 8. Charging Circuits for Small Accumulators

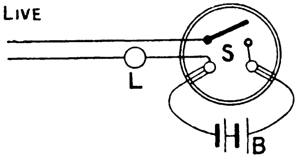


FIG. 156. SMALL ACCUMULATOR CONNECTED TO DISTRIBUTION BOARD THROUGH PLUG-SWITCH AND LAMP

B, small accumulator; *S*, plug switch; *L*, lamp.

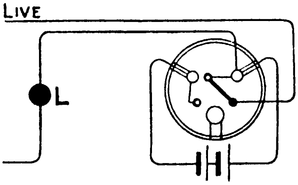


FIG. 157. SMALL ACCUMULATOR CONNECTED TO DISTRIBUTION BOARD THROUGH TWO-WAY PLUG-SWITCH AND LAMP

In one position of the switch the lamp (*L*) is in circuit, but not the accumulator. In the other position, the two are in series.

¶ 9. Reversing Switches

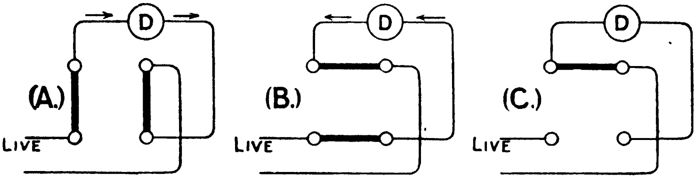


FIG. 158. PARALLEL-OR-SERIES SWITCH (FIG. 115) MODIFIED TO ACT AS A REVERSING SWITCH WITH "OFF" POSITION

D is the apparatus "worked" by the current. At (*A*) the current is flowing from left to right through *D*, at (*B*) it is flowing from right to left, at (*C*) it is off.

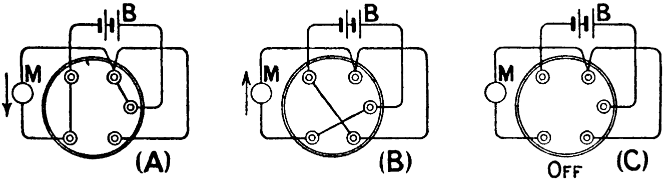


FIG. 159. INTERNAL CONNECTION CHANGES OF MARVEL SWITCH WHEN MODIFIED TO ACT AS A REVERSING SWITCH WITH "OFF" POSITION

This application is shown in conjunction with a battery *B*, and a reversible motor or other device *M*. At (*A*), the current is flowing one way through *M*; at (*B*), in the other direction; while at (*C*) it is off, both poles being disconnected.

The modification illustrated in Fig. 136 will also perform the same function, if the battery or other source of current be connected to the leads marked *D*, *D*, and the motor (or other device) to those marked *M*, *M*.

SECTION IV

SIGN, HEATER, COOKER, AND MOTOR CIRCUITS

¶ 1. Sign Circuits

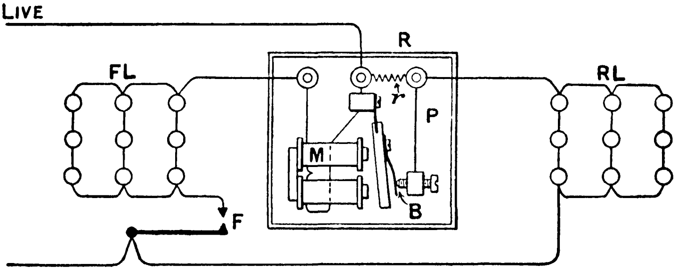


FIG. 160. THERMAL FLASHER RENDERED "TWO-WAY" BY USE OF SPECIAL RELAY
(*Sun. Elec. Co.*)

F, thermal flasher; *FL*, lamps controlled by *F*; *R*, relay; *RL*, lamps controlled by *R*. *M*, relay magnet; *B*, contact points of ditto; *r*, resistance shunting *B* and preventing sparking thereat; *P*, porcelain base.

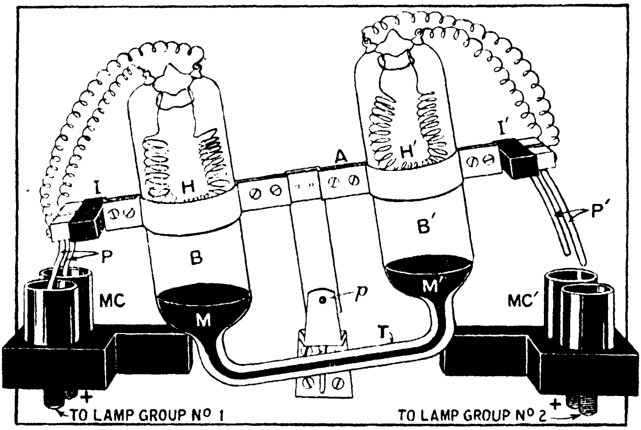


FIG. 161. TWO-WAY THERMAL FLASHER
(*Venner*)

A, arm pivoted at *p*, and carrying bulbs *B*, *B′*, and contact prongs *P*, *P′*, insulated at *I*, *I′*. *B*, *B′*, contain heater coils, *H*, *H′*, and are united by the tube *T* containing mercury *M*, *M′*. *MC*, *MC′* are mercury cups.

Circuit is shown closed at *MC*. As *H* heats up, the air inside *B* expands and forces *M* down and along *T* until the amount of mercury at *M′* exceeds that at *M*. *T* is then tilted by the action of gravity, so that contact is made at *MC′* and broken at *MC*. *H′* then gradually heats up, while *H* cools down. Eventually, the apparatus is tilted the other way again, and *H* heats up once more.

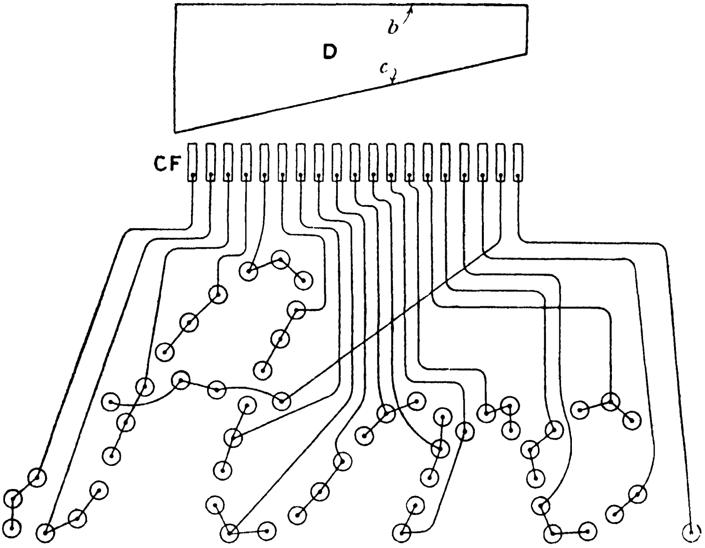
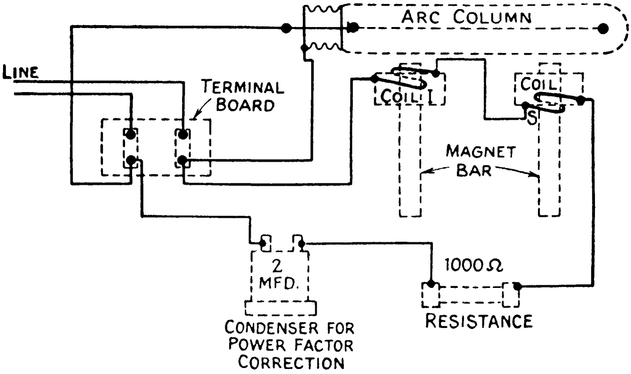


FIG. 162. WRITING SIGN

D, motor-driven drum, with contact-making and -breaking edges *c* and *b*. *CF*, contact fingers.

The word *ARC* is outlined in lamps connected in groups of three, and is gradually "written out" by the action of the contact-drum, *D*, which is connected to one pole of the supply. The other pole is looped into all the lamps, but this connection is not shown. The figure illustrates the principle of this type of sign, but in practice each lamp would generally be lit up separately.



Plan View

FIG. 163. CONNECTIONS OF FLOODLIGHTING LANTERN (*B.T.-H.*)

With "Mercra" lamp in horizontal position. A.C. Supply Choke in the connection to line is not shown.

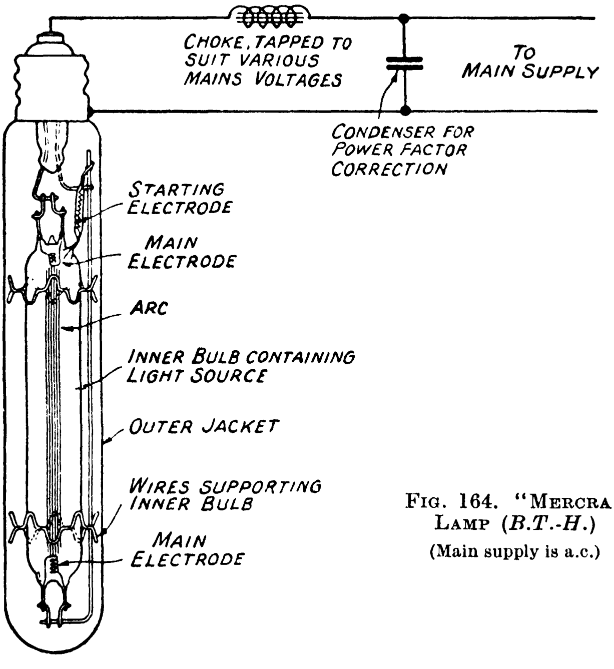
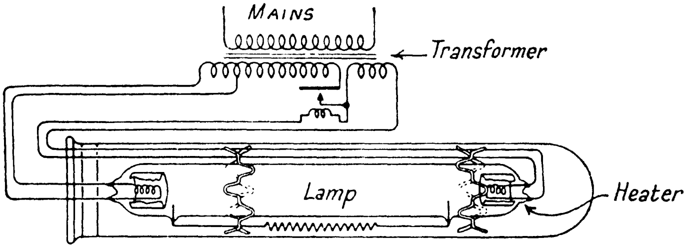
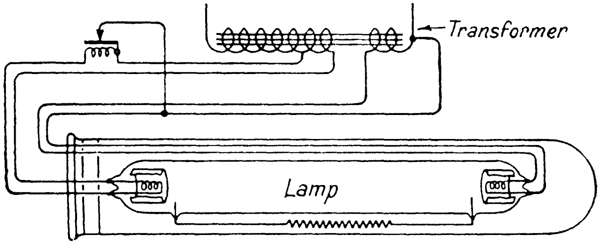

CHOKE, TAPPED TO SUIT VARIOUS MAINS VOLTAGES
TO MAIN SUPPLY
CONDENSER FOR POWER FACTOR CORRECTION
STARTING ELECTRODE
MAIN ELECTRODE
ARC
INNER BULB CONTAINING LIGHT SOURCE
OUTER JACKET
WIRES SUPPORTING INNER BULB
MAIN ELECTRODE

FIG. 164. "MERCRA" LAMP (*B.T.-H.*)
(Main supply is a.c.)



A.C LAMP WITH HIGH REACTANCE TRANSFORMER



A.C. LAMP WITH IMPEDANCE STABILIZATION

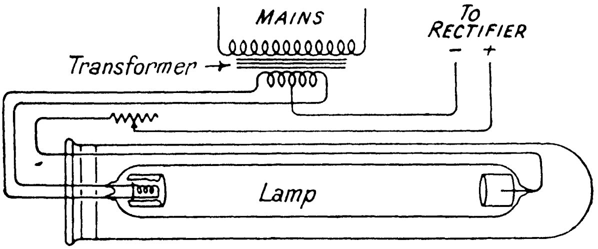


Fig. 165. Forms of Sodium Lamps (*B.T.-H.*)
Shown diagrammatically.

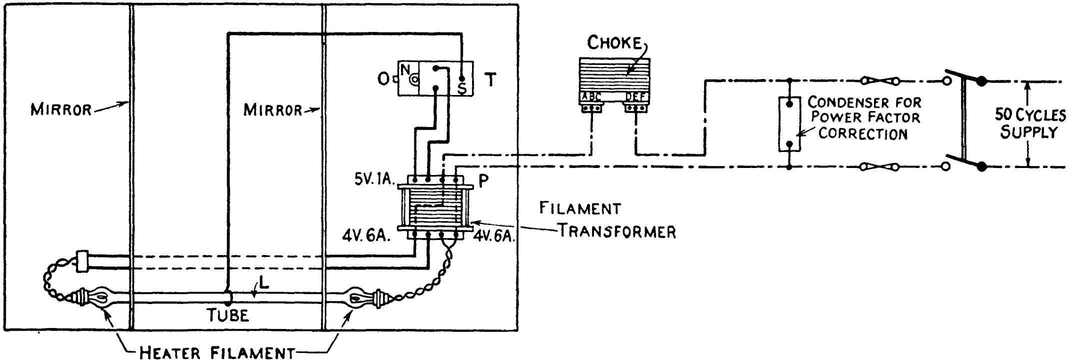


Fig. 166. Wiring Diagram for "Osira" Floodlighting (G.E.C.)

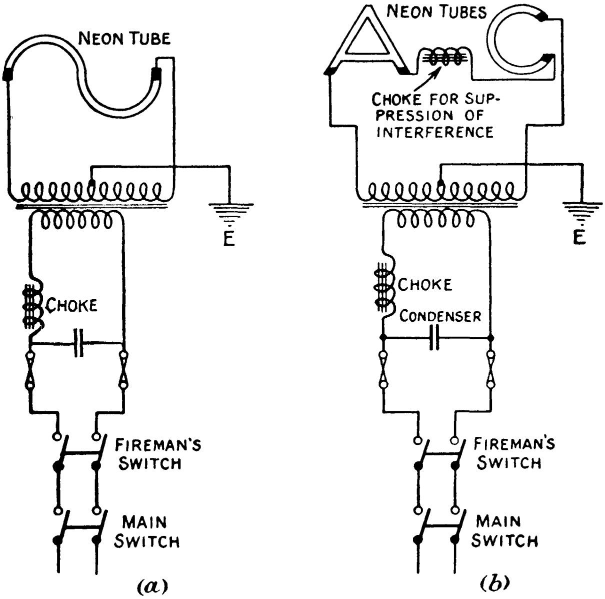


FIG. 167. TYPICAL NEON SIGN CIRCUITS

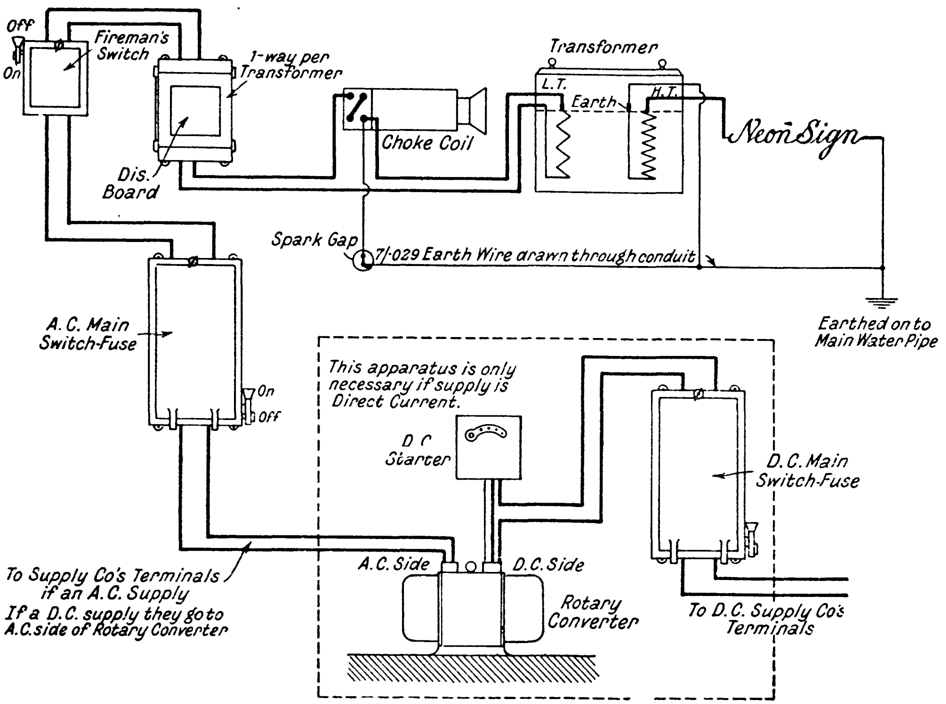

Off
On
Fireman's Switch
1-way per Transformer
Dis. Board
Choke Coil
Transformer
L.T.
Earth
H.T.
Neon Sign
Spark Gap
7/·029 Earth Wire drawn through conduit
Earthed on to Main Water Pipe
A.C. Main Switch-Fuse
On
Off
This apparatus is only necessary if supply is Direct Current.
D C Starter
D.C. Main Switch-Fuse
To Supply Co's Terminals if an A.C. Supply
If a D.C. supply they go to A.C. side of Rotary Converter
A.C. Side
D.C. Side
Rotary Converter
To D.C. Supply Co's Terminals

FIG. 168. CIRCUIT FOR NEON SIGN

¶ 2. Heater Circuits

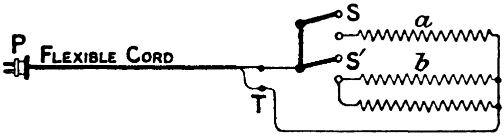


FIG. 169. ONE ARRANGEMENT OF THE INTERNAL CIRCUITS OF A RADIATOR OR CONVECTOR

a, one lamp or resistance section; *b*, two lamps or resistance sections; *T*, terminals; *P*, plug.

S gives one-third, and *S′* two-thirds of the total heat.

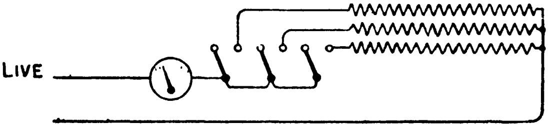


FIG. 170. ANOTHER ARRANGEMENT OF THE INTERNAL CIRCUITS OF A RADIATOR OR CONVECTOR

The three lamps or resistance sections are each controlled by a separate switch; and a current indicator is fitted.

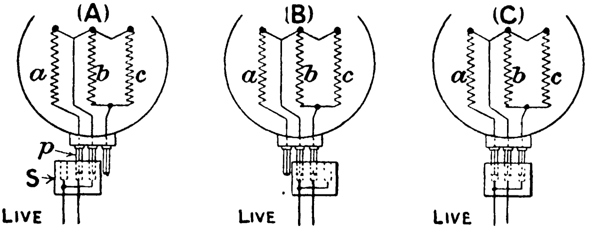


FIG. 171. ONE ARRANGEMENT OF THE INTERNAL CIRCUITS OF HEATERS

The three resistance sections *a*, *b*, *c*, are connected as shown to the three contact-pins *p*. The triple socket *S* has its two outer sockets connected with one pole of the circuit, and its middle socket with the other pole.

At (A), *a* is in circuit; at (B), *b* and *c*; at (C), all three sections.

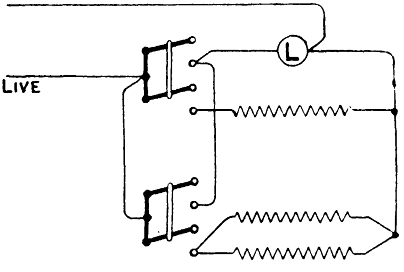


FIG. 172. ARRANGEMENT OF TWO-CIRCUIT HEATER WITH PILOT LAMP

The switches are double ones with the two levers of each linked together. When either is put on, the pilot lamp *L* lights up.

The top switch controls one-third of the heater resistance, and bottom switch two-thirds.

¶ 3. Cooker Circuits

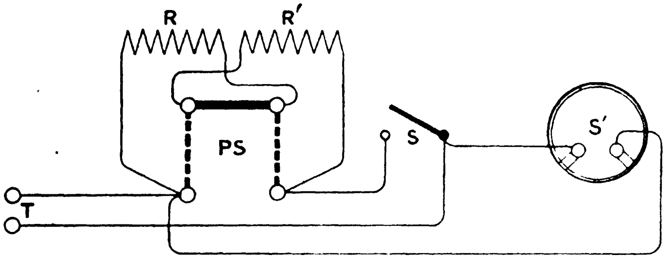


FIG. 173. INTERNAL CONNECTIONS OF BERRY'S "TRICITY" COOKER

T, terminals for attachment of flexible conductor; *PS*, parallel-or-series switch; *S*, ordinary switch; *S′*, two-pin socket for plug-connection; *R*, *R′* resistance sections.

Current is turned on or off from *R* and *R′* at *S*, while *PS* puts *R* and *R′* either in parallel or series. *S′* allows of the attachment of an auxiliary heater.

This arrangement is applicable to other types of heater, and *S′* would then generally be omitted.

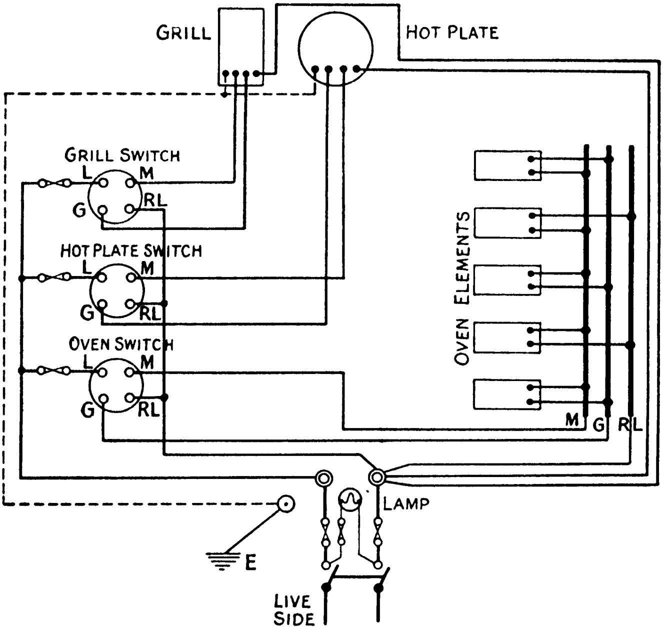


FIG. 174. WIRING DIAGRAM OF "MAGNET" COOKER (*G.E.C.*)

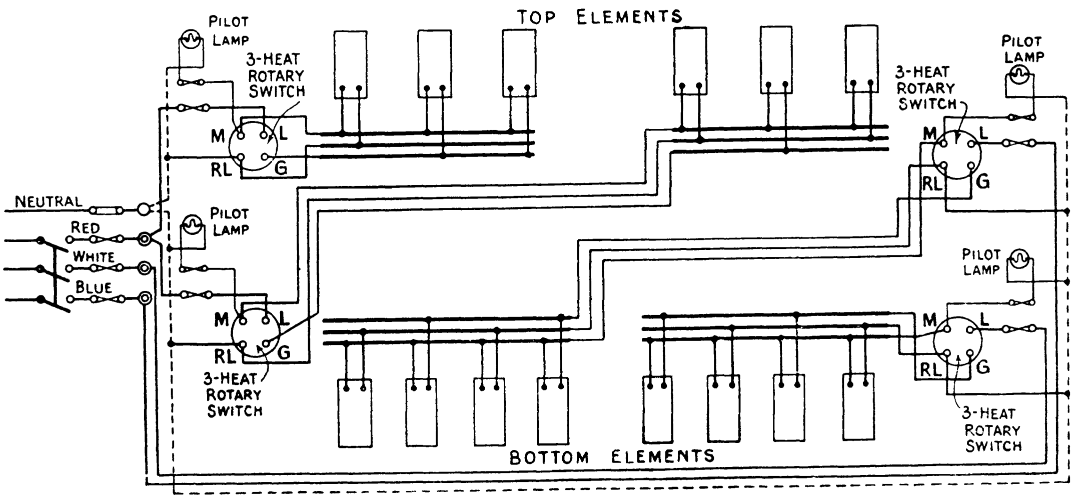


FIG. 175. DIAGRAM OF CONNECTIONS OF A LARGE ELECTRIC OVEN

Arranged for balancing on a 3-phase, 4-wire system.

(G.E.C.)

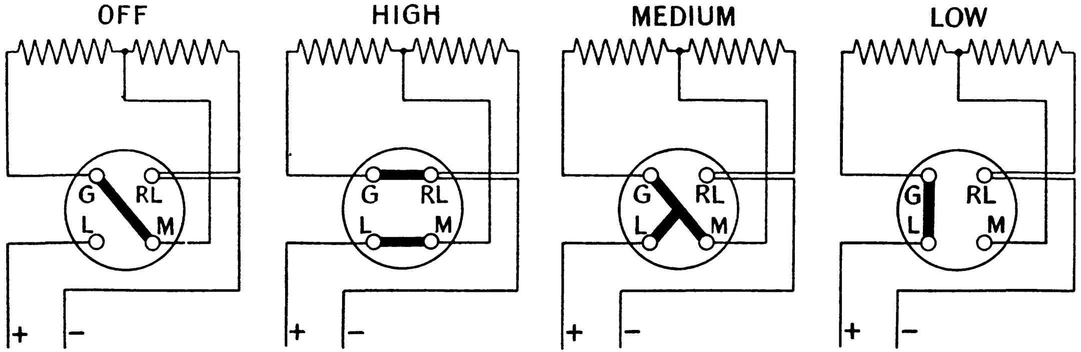


FIG. 176. SWITCH DIAGRAMS—"MAGNET" COOKERS (*G.E.C.*)

L = Line. *RL* = Return Line. *M* = Middle. *G* = Second Element.

In OFF position *M* is connected to *G* while there is no connection to *L* or *RL* and so no current flows.

With switch at "High," *L* is connected to *M*, and *RL* to *G*. One element is fed from *M* through to *RL* and the other from *M* through to *G* which is connected in the switch to *RL*. Both elements are therefore in parallel giving full heat and wattage.

With switch at "Medium," *L* is connected to both *M* and *G*. One element takes current from *M* through to *RL* while no current passes through the second element since *G* is short-circuited to *L*. Half total heat and wattage.

With switch at "Low," *L* is connected to *G*. Current passes from *G* to *RL* through two elements in series. This high resistance results in one quarter of total heat and wattage.

¶ 4. Motor Circuits

4A. D.C. MOTORS

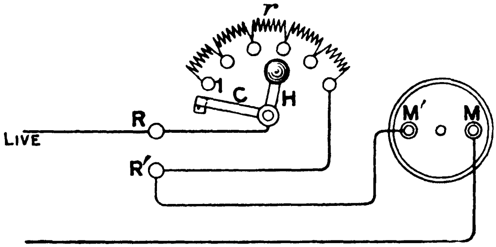


FIG. 177. COMBINED STARTING-SWITCH AND SPEED-REGULATOR FOR SMALL SERIES MOTOR

R, *R′*, terminals of starting switch and regulator; *M*, *M′*, terminals of motor; *r*, resistance sections; *C*, contact arm; *H*, handle fixed at right angles to *C*.

Sometimes the handle is fixed on *C*, as in the next figure.

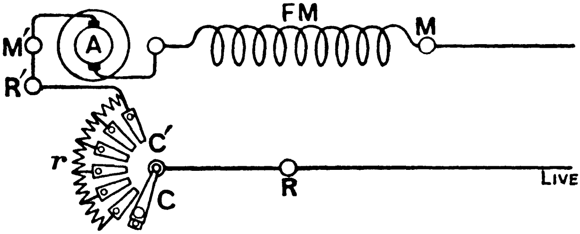


FIG. 178. SIMILAR TO FIG. 177 BUT SHOWING INTERNAL CONNECTIONS OF MOTOR

R, *R′*, terminals of starting switch and regulator; *C*, movable contact arm; *C′*, fixed contact-plates connected with the resistance sections, *r*; *M*, *M′*, terminals of motor; *FM*, field-winding of motor; *A*, armature of motor.

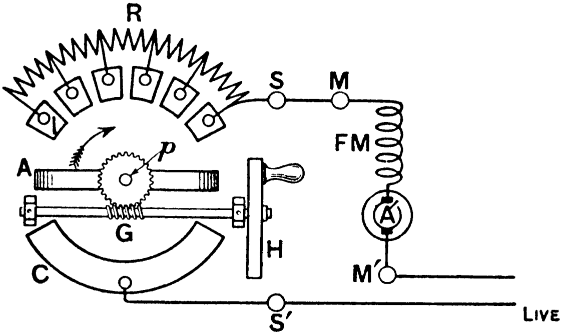


FIG. 179. SLOW-ACTION COMBINED STARTING-SWITCH AND SPEED-REGULATOR FOR SERIES MOTOR

S, *S′*, terminals of starter; *R*, resistance sections; *A*, contact arm pivoted at *p*; *G*, worm gearing operated by handle *H*; *M*, *M′* terminals of motor; *FM*, field-magnet winding; *A′*, armature.

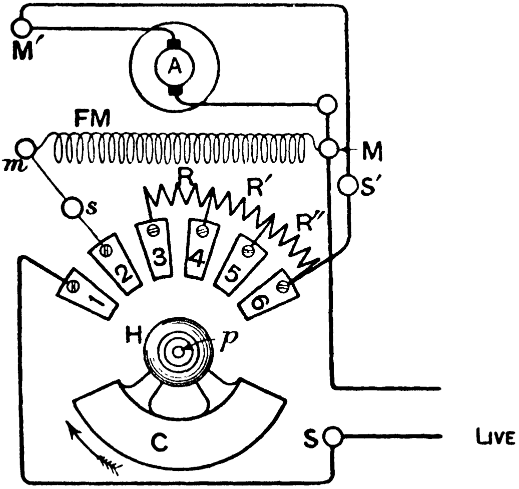


Fig. 180. Simple Starting-switch for Shunt Motor

S, *S′*, *s*, terminals of starter; *R*, *R′*, *R″*, resistance sections; 1–6, fixed contact-plates; *C*, movable contact-plate pivoted at *p* and carrying handle *H*. *M*, *M′*, *m*, terminals of motor; *FM* and *A*, field-magnet winding and armature of motor.

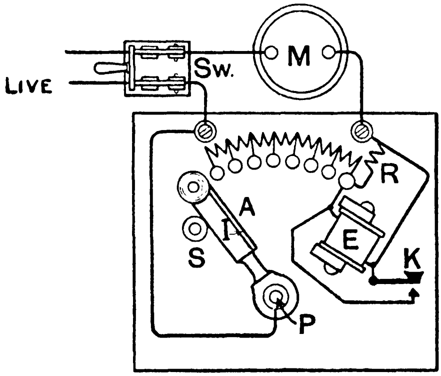


FIG. 181. STARTING SWITCH (WITH NO-VOLTAGE RELEASE) FOR SERIES MOTOR

Sw, d.p. circuit switch; *M*, motor; *E*, hold-on magnet; *A*, arm of starter pivoted at *P* and carrying soft-iron armature, *I*; *K*, short-circuiting or release key; *R*, shunt resistance; *S* stop.

Unless *E* holds *I*, *A* flies to off position against *S* under the influence of a spring coiled about *P*.

Circuit may be opened at *Sw*, or by short-circuiting *E* at *K*.

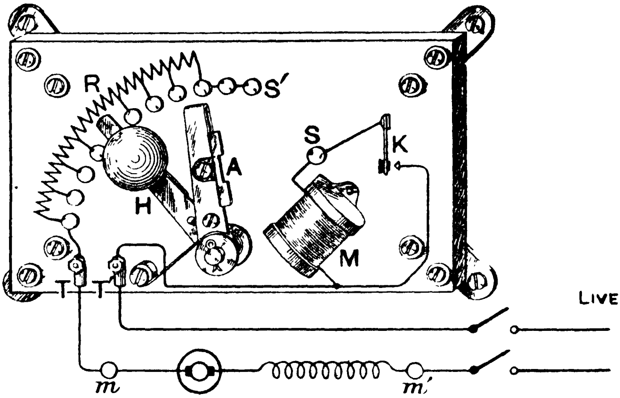


FIG. 182. COMBINED STARTING-SWITCH AND SPEED-REGULATOR (WITH NO-VOLTAGE RELEASE) FOR SERIES MOTOR

(Veritys)

m, *m′*, terminals of motor; *T*, *T′*, terminals of starter; *R*, resistance sections; *M*, hold-on magnet; *K*, short-circuiting or release key; *A*, armature arm; *S*, contact stud; *H*, handle and regulator arm.

The circuit is not closed until *H* and *A* are moved round so that the end of *A* makes contact with *S* and *H* with *S′*. *H* is then moved gradually back until the resistance *R* in circuit is reduced as required. If the supply fails or *K* is depressed *A* will be released by *M* and will fly off (pushing *H* in front of it) under the influence of the coiled spring seen in the figure.

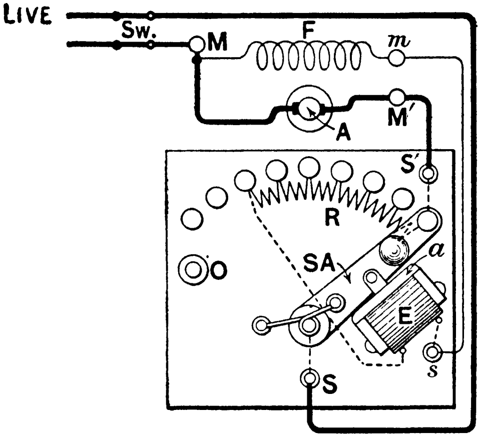


FIG. 183. STARTING SWITCH (WITH NO-VOLTAGE RELEASE) FOR SHUNT MOTOR

Sw, circuit switch; *M*, *M′*, *m*, terminals of motor; *F* and *A*, field-winding and armature of motor. *S*, *S′*, *s*, terminals of starting switch; *SA*, switch arm with armature *a*; *E*, hold-on magnet; *R*, resistance sections; *O*, off stop.

If the supply fails or *Sw* be opened, *E* will release *SA*, which will then fly back against *O*, under pressure of the wire spring shown coiled about its pivot.

A simplified arrangement of the connections is given in the figure below.

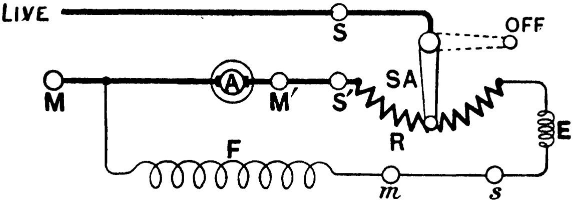


FIG. 184. SIMPLIFICATION OF FIG. 183

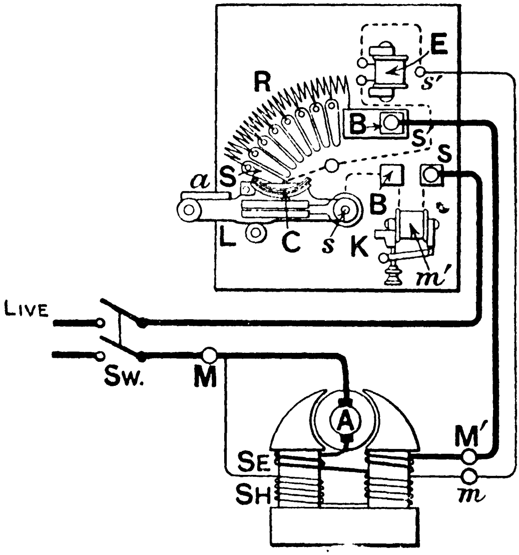


Fig. 185. Starting Switch (with No-voltage and Excess-current Release) for a Shunt or Compound Motor
(Sturtevant)

Sw, d.p. circuit switch; *M*, *M'*, *m*, motor terminals; *A*, motor armature; *Sh* and *Se*, shunt and series windings of motor.

S, *S'*, *s'*, terminals of starting switch; *L*, contact lever pivoted at *s*, and carrying soft-iron armature *a* and laminated contact-piece, *C*; *R*, resistance sections; *B*, *B*, contact blocks; *E*, hold-on magnet; *m'*, excess-current release magnet. *K* are contacts which short-circuit *E* when brought together by the pulling-up of the armature of *m'*. The short-circuiting connections are omitted in this figure, but are shown in the simplified diagram below.

When *L* is moved round so that *a* is held by *E*, *C* makes contact between *B* and *B*, and provides an alternative path for the current to that through *s*. If the supply fails, *E* will release *a*, and *L* will fly off under the influence of a helical spring coiled round *s*. *L* will also be released if an excessive current passes through *m′* (which is in the main circuit), as *m′* will then attract its armature and short-circuit *E* through *K*, as already explained.

The motor may be stopped by hand by lifting the armature of *m′*, or by opening *S*w.

If the motor is a shunt one, the only difference in the diagram would be that the series winding *Se* would be non-existent, and the armature *A* would be connected straight across between the main terminals *M* and *M′*.

A simplified arrangement of the connections is given in the figure below.

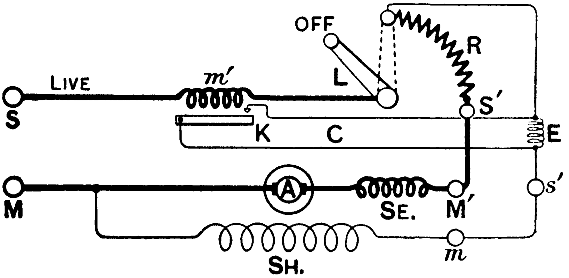


Fig. 186. Simplification of Fig. 185

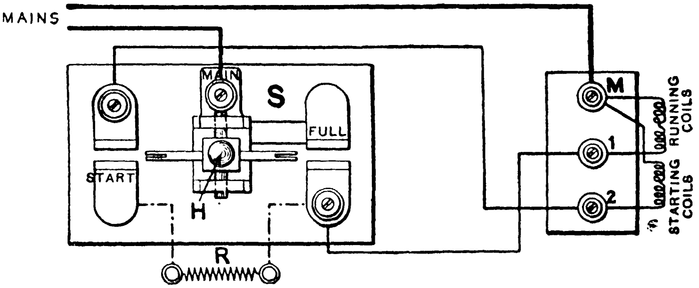


FIG. 187. STARTING SWITCH FOR THE SMALLER SIZES OF LANGDON-DAVIES MOTOR

M, 1, 2, terminals on motor; *S*, two-way off starting switch; *H*, handle of switch; *R*, starting resistance.

Switch is shown in off position.

4B. SINGLE-PHASE A.C. MOTORS

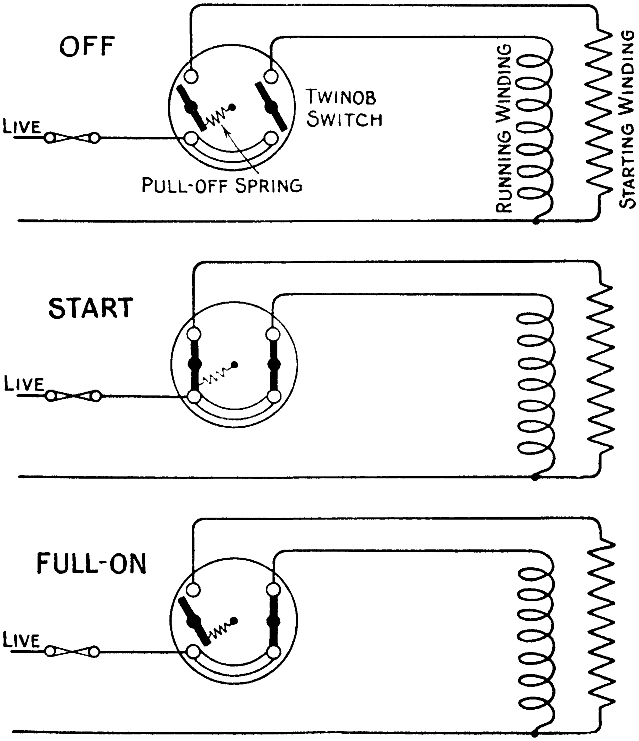
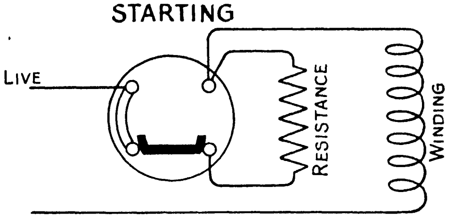
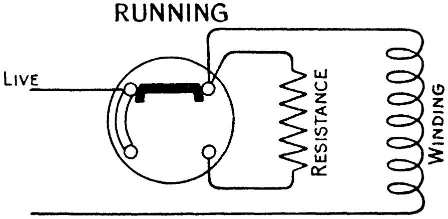


FIG. 188. CONNECTIONS OF "TWINOB" CONTROL SWITCH FOR SMALL SINGLE-PHASE MOTOR

(*Lundberg*).



RESISTANCE IN SERIES



RESISTANCE CUT OUT

FIG. 189. ALTERNATIVE CONNECTIONS OF "TWINOB" CONTROL SWITCH FOR SMALL SINGLE-PHASE MOTOR

(Lundberg)

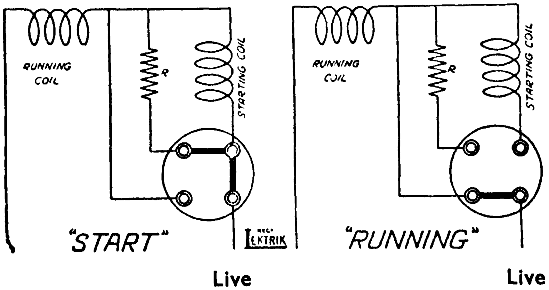


FIG. 190. STARTING CONNECTIONS FOR SINGLE-PHASE A.C. MOTOR (*Lundberg*)

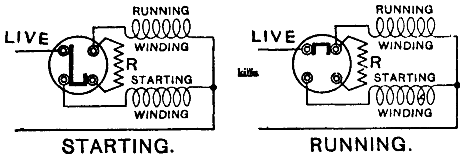


FIG. 191. ALTERNATIVE ARRANGEMENT TO THAT SHOWN IN FIG. 190 (*Lundberg*)

Using a different type of switch.

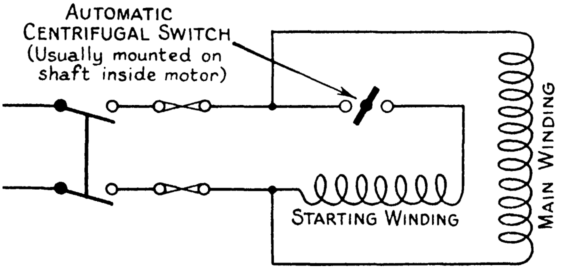

AUTOMATIC CENTRIFUGAL SWITCH (Usually mounted on shaft inside motor)
MAIN WINDING
STARTING WINDING

FIG. 192. CONNECTION SCHEME OF INDUCTION MOTOR (*B.T.-H.*)

When starting, the automatic centrifugal switch is closed, causing the teazer (or starting) winding to be in circuit. When the speed has reached practically its normal value, the automatic switch opens, thereby cutting out the teazer winding.

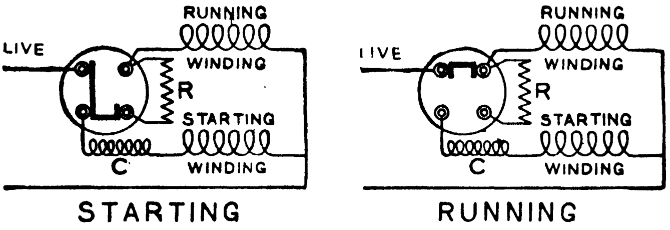


FIG. 193. CONNECTIONS OF SWITCH FOR CONTROLLING VERY SMALL SINGLE-PHASE MOTOR THROUGH STARTING CHOKER AND RESISTANCE (*Lundberg*)

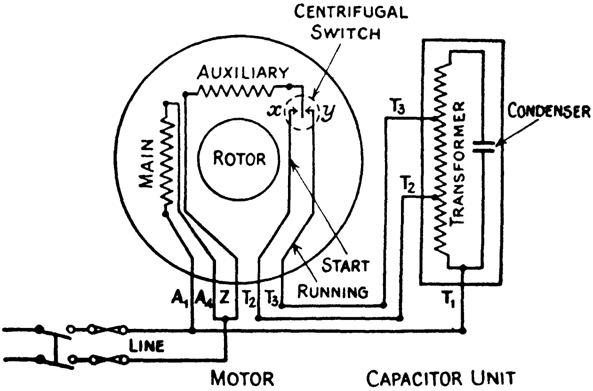


FIG. 194. B.T.-H "CAPACITOR" MOTOR

x = Switch in circuit at start, connecting one-third of transformer windings across the motor coils.

y = Switch in circuit when the motor is up to speed. Approximately two-thirds of transformer windings in circuit across motor windings. The transformer tappings can be varied at will.

T_1, T_2, T_3 = Transformer tappings to motor auxiliary winding.

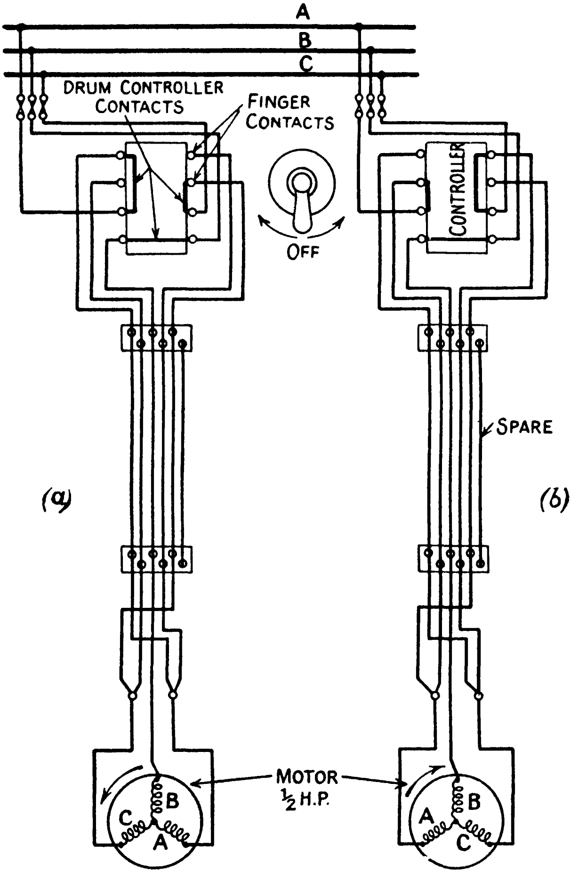


FIG. 195. SMALL THREE-PHASE MOTOR OPERATED BY SPECIAL CONTROLLER WHICH REVERSES ROTATION

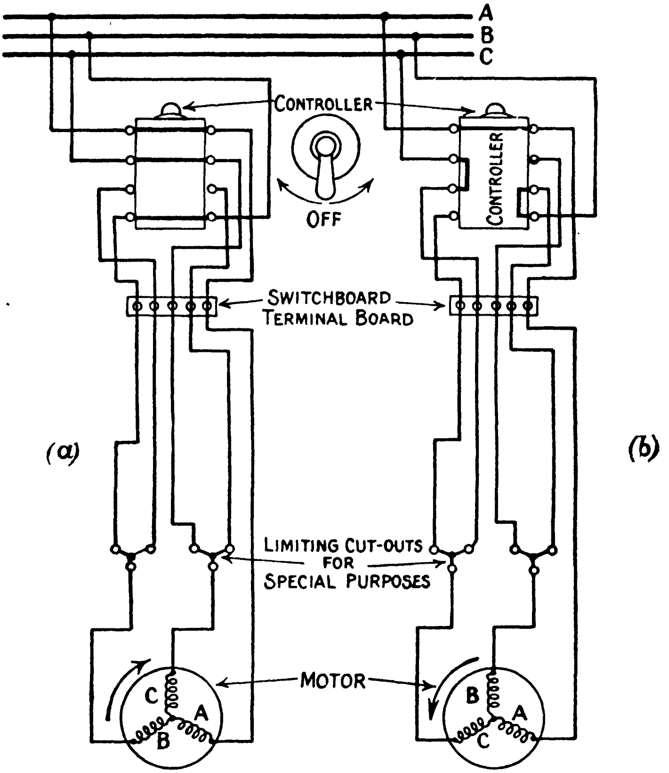


FIG. 196. SMALL THREE-PHASE MOTOR OPERATED BY SPECIAL CONTROLLER WHICH REVERSES ROTATION

(*Note.* Figs. 195 and 196. When the controller handle is moved 60° to the left the contact bridges fixed on the drum make contact with certain fingers as shown in (*a*). When the handle is moved over to 60° on the opposite side as shown in (*b*), the new connections change over two of the three motor phases with the result that the motor reverses its direction of rotation.)

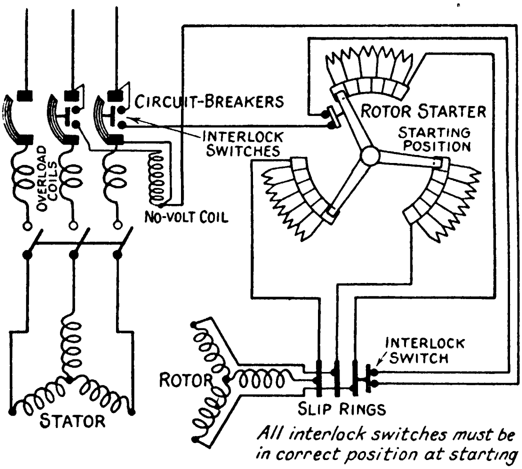


FIG. 197. RESISTANCE STARTING OF MEDIUM SIZE THREE-PHASE WOUND ROTOR SLIP-RING INDUCTION MOTOR

This motor differs from squirrel cage motors in that the rotor is wound with three separate insulated windings which are *star* connected and the open ends of the windings are brought out to slip-rings mounted on the shaft. These rings are connected to a 3-phase star-connected starting rheostat, and it is also the usual practice to short-circuit the rings when the machine is up to speed and to lift the brushes off the rings thus isolating the starter from the circuit. When starting up it is essential that the short-circuiting switch is "out" and that the rheostat is in the starting position. In the above diagram an auxiliary interlock circuit is provided which ensures that these conditions obtain. The circuit-breaker is fitted with a lock-out pawl (not shown) which is operated by the *holding in* or *no-volt* coil. This pawl allows the breaker to close sufficiently to make contact on the auxiliary switches, but should either of the contacts on the rheostat or short-circuiting switch be open then the coil circuit is not made, hence the breaker cannot be closed.

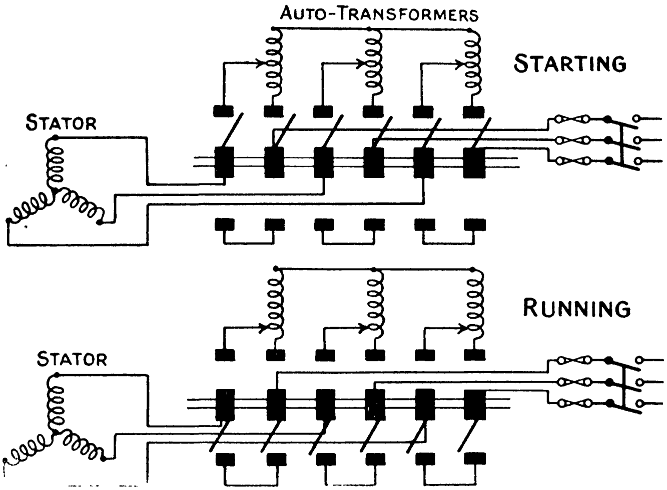
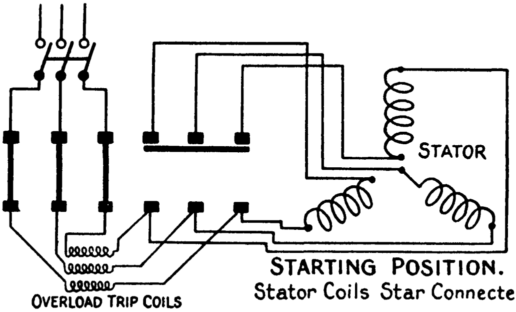
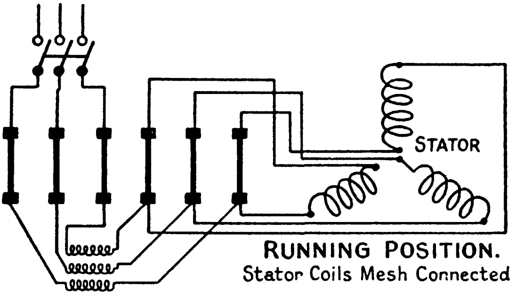


FIG. 198. AUTO-TRANSFORMER STARTER FOR MEDIUM SIZE THREE-PHASE INDUCTION MOTOR

Shows the *auto-transformer* or *reactance* method of starting up induction motors. In this case, when the operating switch is closed in starting position an auto-transformer is connected in the circuit, thus reducing the starting current. When the machine is up to speed the switch is thrown over to running position, which connects the motor direct to the mains and isolates the auto-transformer from the circuit.



STARTING POSITION.
Stator Coils Star Connected.



RUNNING POSITION.
Stator Coils Mesh Connected.

Fig. 199. Drum-type Star/Delta Starter for Medium Size Three-phase Induction Motor

The object of this method of starting is to reduce the current taken from the mains when switching in. It can be shown that the pressure impressed upon each phase winding is 0·58 times the line voltage; therefore the current will be much lower than it would be if the machine were switched direct on the line in "mesh." All ends of the windings are brought out of the motor to a terminal block and these are connected to the controller in such a way that when the controller is moved to starting position the neutral ends will be connected to a common contact on the drum and the other ends connected to the lines. When the machine is up to speed the controller is quickly changed to "running" position, which breaks the star and reconnects the various leads in mesh. These two operations will be readily seen in the two diagrams above.

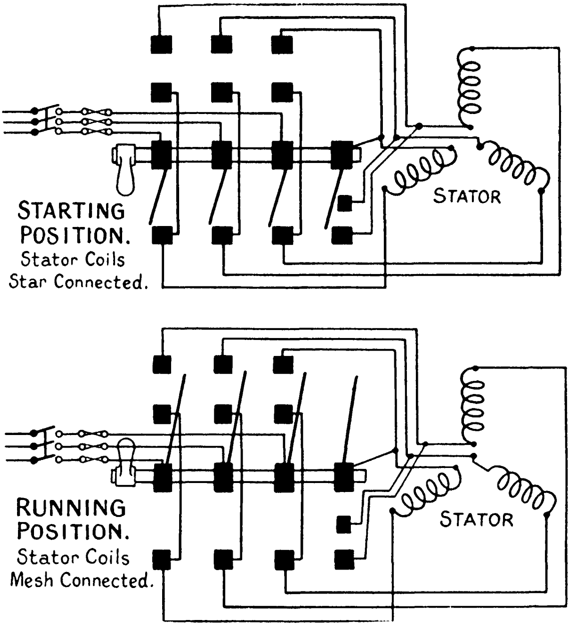


FIG. 200. STAR/DELTA STARTER FOR THREE-PHASE MOTOR

(*Note.* Figs. 197, 198, 199 and 200 are typical examples of methods employed to "start-up" induction motors of medium or large powers. Figs. 199 and 200 are examples of star-delta starting in which it should be noted that when the controller or switch is in the starting position the stator coils are star connected, but when they are thrown over to "running" the stator coils are mesh connected.)

SECTION V

BELL, ALARM, TELEPHONE, AND CLOCK CIRCUITS

¶ 1. Maycock's Rule for Electric Bell and Kindred Wiring

All the wires in any electric bell, telephone, or signalling circuit, no matter how complicated the circuit, may be classified under three heads—

(*a*) + *battery wires*, or wires leading direct to the + pole of the battery.

(*b*) — *battery wires*, or wires leading direct to the — pole of the battery.

(*c*) *Connecting wires*, or wires passing between apparatus (as from push to indicator, fire alarm to bell, etc., etc.), and not connected directly with the battery.

The desirability of being able to distinguish between these wires at a glance will be understood by all who have had any experience with electric-bell fitting; as the progress of the work, and subsequent repairs or additions to it, are greatly facilitated thereby. Further, the initial planning out of a "circuit-diagram" of the work, of which every bell-fitter should be capable, is far easier to accomplish, and much more certain to be correct.

The only rule which fulfils these conditions is that devised some years ago by the Author, and is as follows—

In wiring, all wires leading from the + pole of the battery (+ battery wires) to any push, etc., should be of a plain bright colour (preferably white, yellow, or red): all wires leading direct to the — pole of the battery (— battery wires) should be of a plain dark colour (preferably blue or black): and all wires running between apparatus (connecting wires), should have a covering in which two or more colours are woven.

In drawing circuit diagrams, + battery wires should be shown in red pencil or red ink, or, if these are not available, by thin black lines; — battery wires by black ink or thick black lines; and connecting wires by dotted lines.

The circuit diagrams in this section are nearly all drawn in accordance with the above rule.

Several circuits are shown with *earth returns* to emphasise the fact that an earth connection can be used when necessary; but with ordinary distances there would be no gain, and the circuit would be wholly of wire. On the other hand, an earth return could be introduced in some of the circuits where none is shown.

¶ 2. Bell Circuits

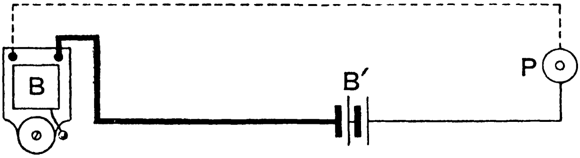


Fig. 201. Simple Bell Circuit

Push *P* rings Bell *B* from Battery *B′*.

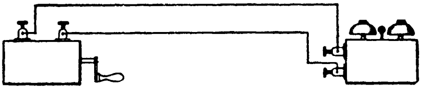


Fig. 202. Magneto Generator connected to Polarised Bell

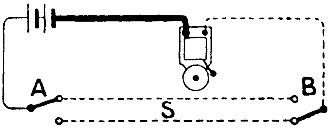


Fig. 203. Bell and Battery connected to Two-way Switches

A and *B*, switches; *S*, strapping wire between the switches. The bell may be started or stopped at either switch. The switches must not have off positions.

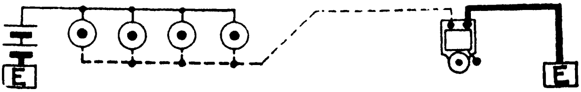


Fig. 204. Bell and Battery connected to Pushes

A wire may be substituted for the earth return.

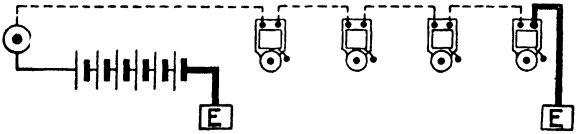


FIG. 205. PUSH AND BATTERY CONNECTED TO RING A NUMBER OF BELLS IN SERIES

The bells must be adapted for series working.
A wire may be substituted for the earth return.

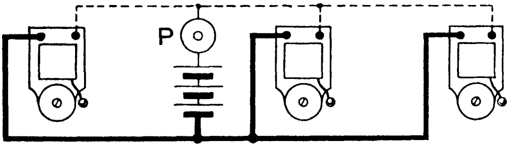


FIG. 206. SINGLE PUSH RINGING A NUMBER OF BELLS IN PARALLEL FROM ONE BATTERY

P, push.

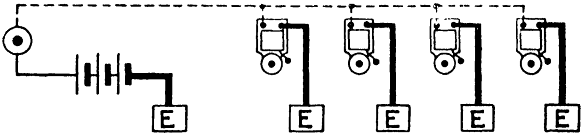


FIG. 207. PUSH AND BATTERY CONNECTED TO RING A NUMBER OF BELLS IN PARALLEL

A wire or wires may be substituted for the earth return.

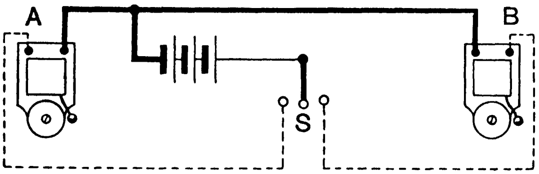


FIG. 208. TWO-WAY SWITCH AND BATTERY CONNECTED TO RING EITHER OF TWO BELLS

A, *B*, bells; *S*, switch.

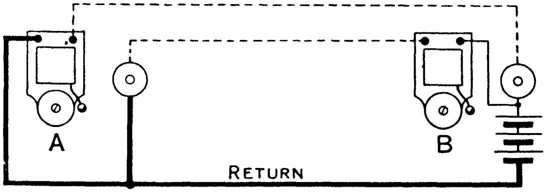


FIG. 209. PUSHES CONNECTED TO RING A BELL AT SOME DISTANT POSITION

A push at *A* rings a bell at *B*, and a push at *B* a bell at *A*. One battery only. Three wires between the two places.

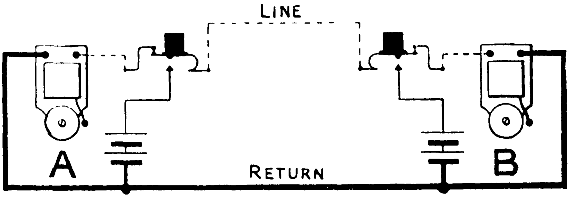


FIG. 210. PUSHES CONNECTED TO RING A DISTANT BELL USING TWO BATTERIES

A morse push at *A* rings a bell at *B*, and a similar push at *B* a bell at *A*.

Two wires between the two places.

A battery at each place.

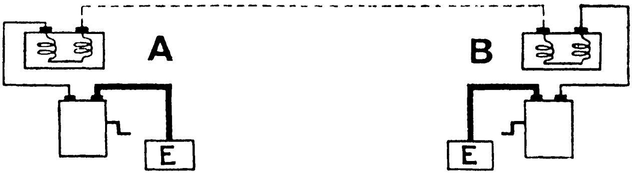


FIG. 211. MAGNETO BELL RINGING CIRCUITS

A magneto generator at *A* rings a polarised bell at *B*, and a generator at *B* a bell at *A*.

A wire may be substituted for the earth return.

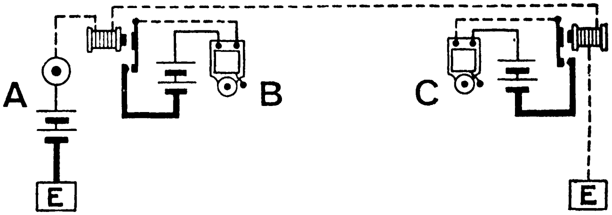


FIG. 212. BELL CIRCUIT, USING RELAYS FOR OPERATING BELLS

A push and battery at *A* actuate spring relays at *B* and *C*, the relays closing local battery and bell circuits.

Three batteries.

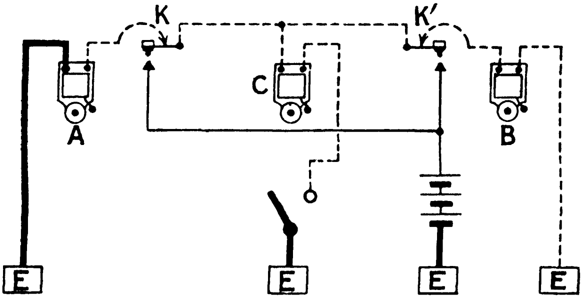


FIG. 213. SPECIAL BELL CIRCUIT

Morse push *K* rings bell *B*. Morse push *K′* rings bell *A*. If switch be on, bell *C* will ring in each case.

One battery only.

A wire may be substituted for the earth returns.

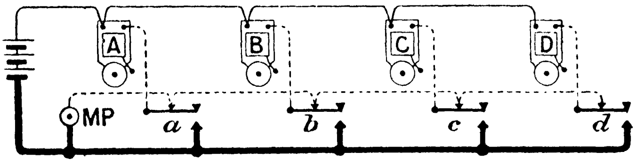


FIG. 214. BELL CIRCUIT WITH MASTER PUSH IN CIRCUIT

Morse pushes *a*, *b*, *c*, and *d* ring bells *A*, *B*, *C*, or *D* respectively. The master push *MP* rings all the bells.

One battery only.

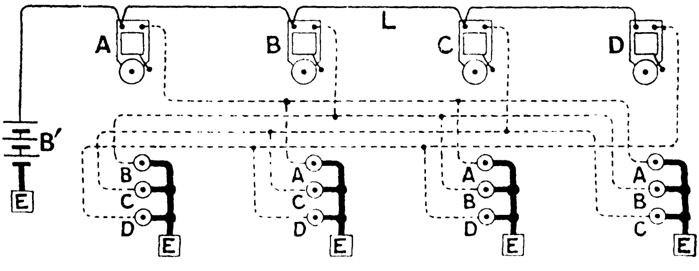


FIG. 215. BELL CIRCUIT: EACH BELL RUNG FROM SEVERAL POINTS

At each place *A*, *B*, *C*, *D*, there are a bell and three pushes. The pushes at any one place actuate the bells at the other three places as lettered.

One battery *B′* only.

A wire may be substituted for the earth returns.

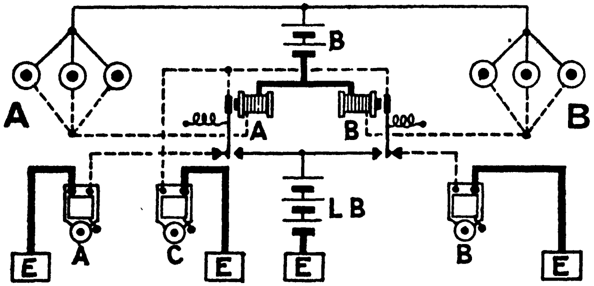


FIG. 216. BELL CIRCUITS USING RELAYS FOR COMPLETING THE CIRCUIT TO CERTAIN BELLS

Three pushes *A* actuate relay *A*, which rings bells *B* and *C*. Three pushes *B* actuate relay *B*, which rings bells *A* and *C*.

Battery *B* supplies the current for the push circuits, and battery *LB* that for the relay circuits.

Wire may be substituted for the earth returns.

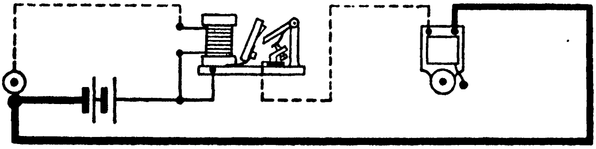


FIG. 217. CONTINUOUS RINGING BELL CIRCUIT

Push actuates drop relay, which keeps bell circuit closed until contact lever is replaced.

One battery only.

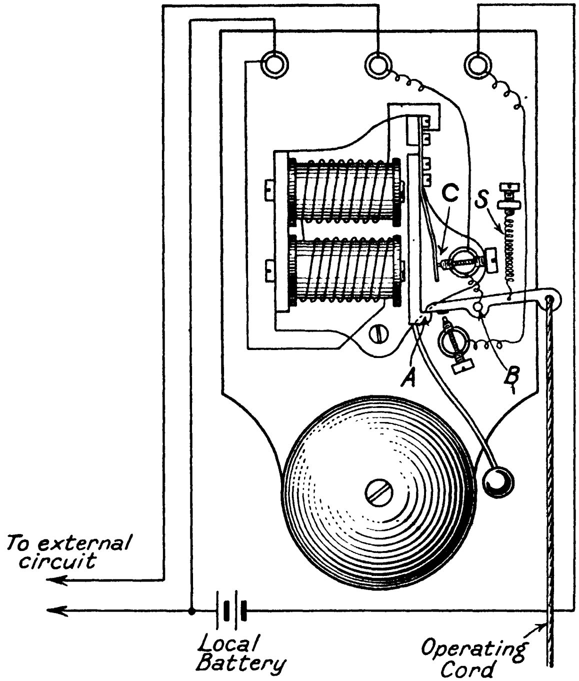


FIG. 218. CONTINUOUS RINGING BELL

The continuous ringing bell does not greatly differ from the ordinary trembler bell. The additional parts include an extra contact pillar, and a metal trigger *B* to which is attached an operating spring *S* and an operating cord for resetting the trigger after operation.

Under normal conditions the circuit is similar to the standard bell, but when the circuit is completed externally the armature is attracted and the trigger is released from the catch *A*, thus allowing the spring to force the trigger to make contact with bottom pillar.

This action causes a local circuit to be completed thus: local battery positive to left hand terminal, through coils to make-and-break contact *C*, thence to trigger and through bottom pillar to top right hand terminal and negative of battery.

The bell will continue to ring until the trigger is reset by pulling the operating cord down.

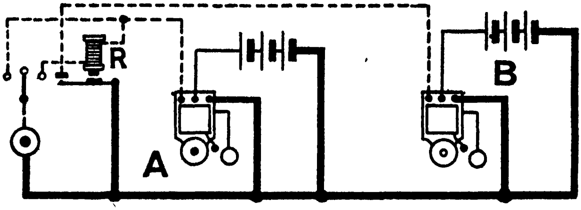


FIG. 219. CIRCUIT PROVIDING FOR ALTERNATIVE RINGING OF CONTINUOUS-RINGING BELLS

When the two-way switch is on its left-hand contact, and the push is pressed, the continuous ringing bell at *A* is started and rung from its local battery. If the switch be on its right-hand contact, the relay *R* will be actuated, and the continuous-ringing bell and battery at *B* set in action.

The terminal connections of the bells are different from those in Fig. 218. In any given case these depend on the internal connections of the bell or bells.

Two batteries.

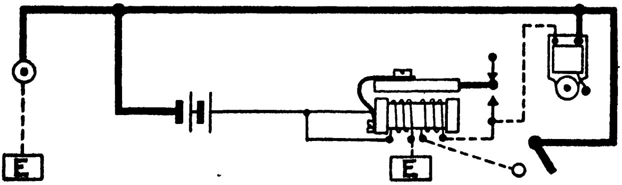


FIG. 220. BELL CIRCUIT USING SPECIAL RELAY

If the switch be open, the push will ring the bell through the *Callows' relay*, only so long as it is pressed. If the switch be closed, and the push pressed, the relay armature will be held down, and the bell will keep ringing until the switch is opened. A wire may be substituted for the earth return.

One battery.

¶ 3. Bell and Indicator Circuits

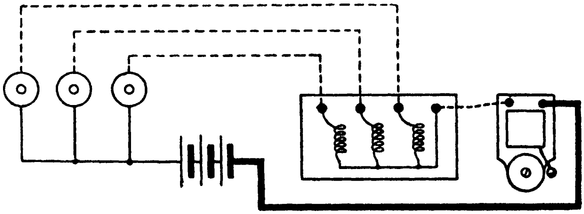


FIG. 221. PUSHES CONNECTED TO A BELL THROUGH A MECHANICAL REPLACEMENT OR PENDULUM INDICATOR

One battery.

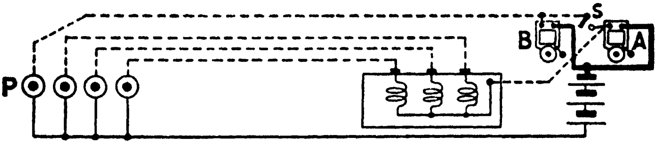


FIG. 222. PUSHES CONNECTED TO A BELL THROUGH A MECHANICAL REPLACEMENT OR PENDULUM INDICATOR

A, *B*, bells. Three pushes ring bell *A*. An extra push *P* rings bell *B*. If the switch *S* be closed, *P* rings bell *A* also.

One battery.

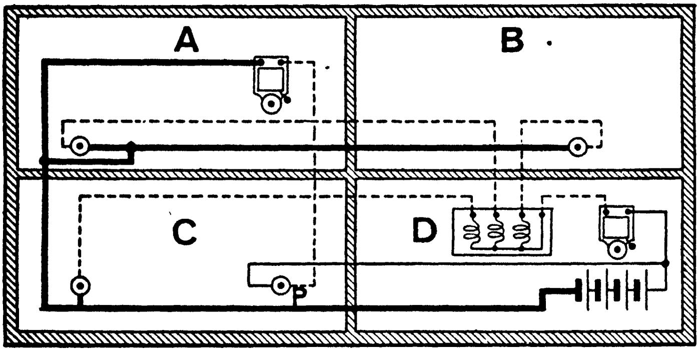


FIG. 223. HOUSE BELL AND INDICATOR CIRCUIT

A push in each room *A*, *B*, and *C* rings a bell in *D* through a mechanical-replacement or pendulum indicator. Push *P* in *C* rings a bell in *A*.

One battery only.

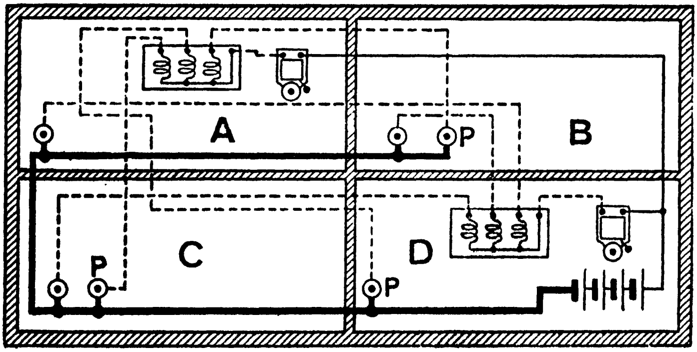


FIG. 224. CIRCUITS FOR OPERATING INDICATORS AT DIFFERENT POSITIONS FROM SEVERAL ROOMS

The unmarked push in each of the three rooms *A*, *B*, and *C* rings a bell in room *D* through a mechanical-replacement or pendulum indicator. A similar indicator and bell in room *A* is actuated by the pushes marked *P* in the other three rooms.

One battery only.

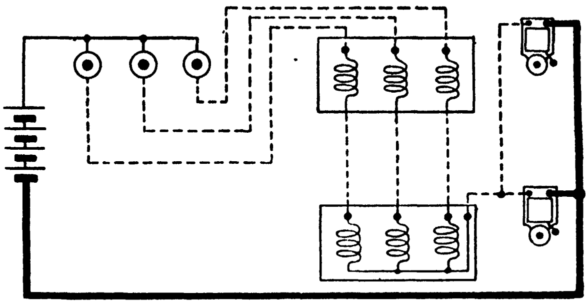


FIG. 225. INDICATOR AND BELL CIRCUIT

Pushes connected to two mechanical-replacement or pendulum indicators in series, with a bell by each indicator.

One battery only.

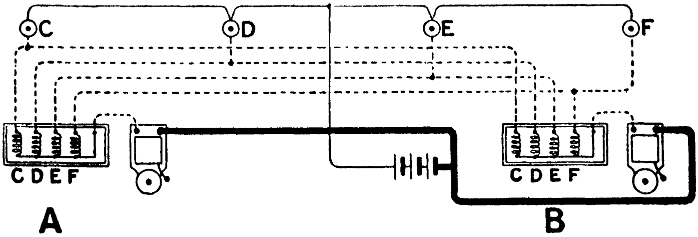


FIG. 226. INDICATOR AND BELL CIRCUIT

Pushes connected to two mechanical-replacement or pendulum indicators in parallel, with a bell by each indicator.

One battery only.

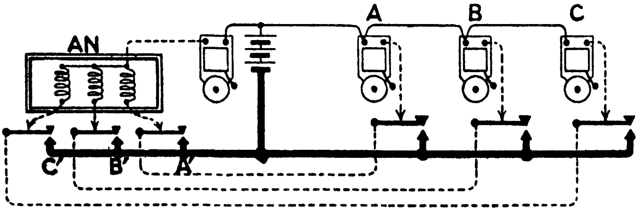


FIG. 227. INDICATOR AND BELL CIRCUIT

Morse pushes at *A*, *B*, and *C* work through a mechanical-replacement or pendulum indicator and bell. Reply rings may be given on the bells at *A*, *B*, and *C* by means of the morse pushes *A′*, *B′*, and *C′*, respectively; these being fixed beneath the indicator, and in line with the corresponding indicator movements.

One battery.

This arrangement should be compared with that in Fig. 238.

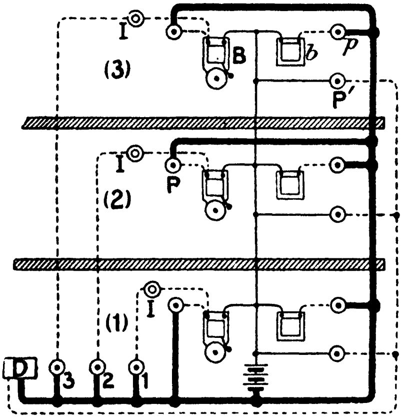


FIG. 228. SPECIAL BELL CIRCUIT USING INDICATORS AND BUZZERS

The bell *B* on each floor (1), (2), and (3), which may be a flat or suite of offices, may be rung from correspondingly-marked pushes 1, 2, and 3 at the entrance, through a pendulum indicator-movement *I*. Or the corresponding bell may be rung from a push *P* at the door of the flat. At the back entrance is a buzzer *b* operated from an adjacent push *p*. If the main door is fitted with an electric latch or lock *D*, this may be operated from a push *P′* on each floor.

One battery only.

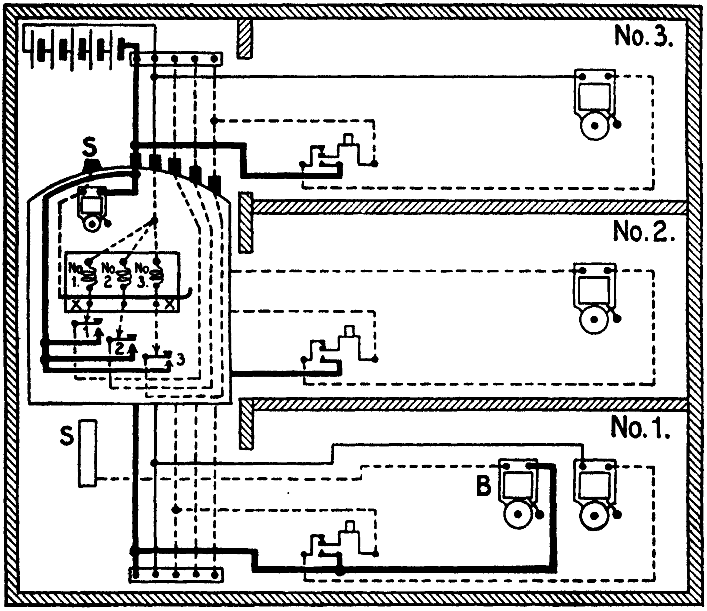


FIG. 229. A METHOD OF PROVIDING ELECTRICAL COMMUNICATION BETWEEN THE DIFFERENT FLOORS OF A BUILDING AND A LIFT

If the morse push on either floor be pressed, the lift indicator (mechanical-replacement) and bell will be actuated. The attendant replies by pressing the morse push inside the lift corresponding with the floor which has signalled, this causing the bell on that floor to ring.

Bell *B* is in the attendant's room. If he leaves the lift for a while, when it is at the bottom of the shaft, bell B will be in parallel with the lift bell through contact springs *S*, *S*; and will thus give notice of any summons.

One end of each indicator coil is fixed to its framework, and the circuit of the lift bell and bell *B* is completed by the dropping of the indicator shutters on to the replacing bar *x*, *x*.

One battery only.

Indicator movements similar to those in Figs. 231 or 232 might be used; or the bell might be connected in the common wire at the top of the indicator, and ordinary movements fitted.

If the reply pushes and bells be dispensed with, ordinary pushes may be used on the landings, and the connections then become very simple.

¶ 4. Bell and Relay-indicator Circuits

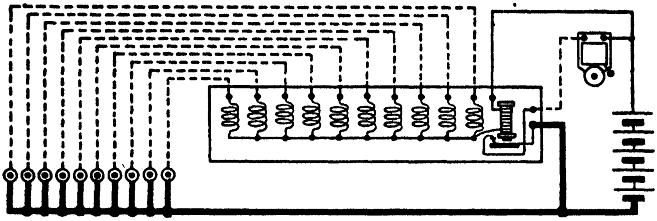


FIG. 230. A NUMBER OF PUSHES CONNECTED TO A BELL THROUGH A MECHANICAL-REPLACEMENT OR PENDULUM RELAY-INDICATOR

One battery.

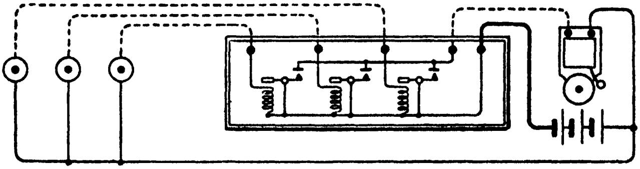


FIG. 231. PUSHES CONNECTED TO A BELL THROUGH A MECHANICAL-REPLACEMENT OR PENDULUM INDICATOR WITH RELAY CONTACTS ON EACH MOVEMENT

One battery.

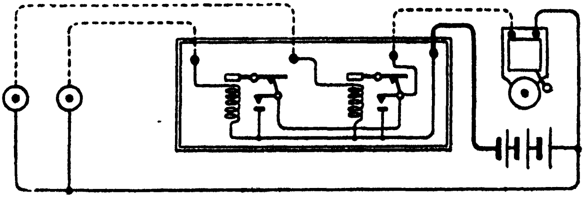


FIG. 232. PUSHES CONNECTED TO A BELL THROUGH A MECHANICAL-REPLACEMENT INDICATOR WITH DROP-RELAY CONTACTS ON EACH FLAG ARM

Bell rings until indicator movement is replaced.
One battery.

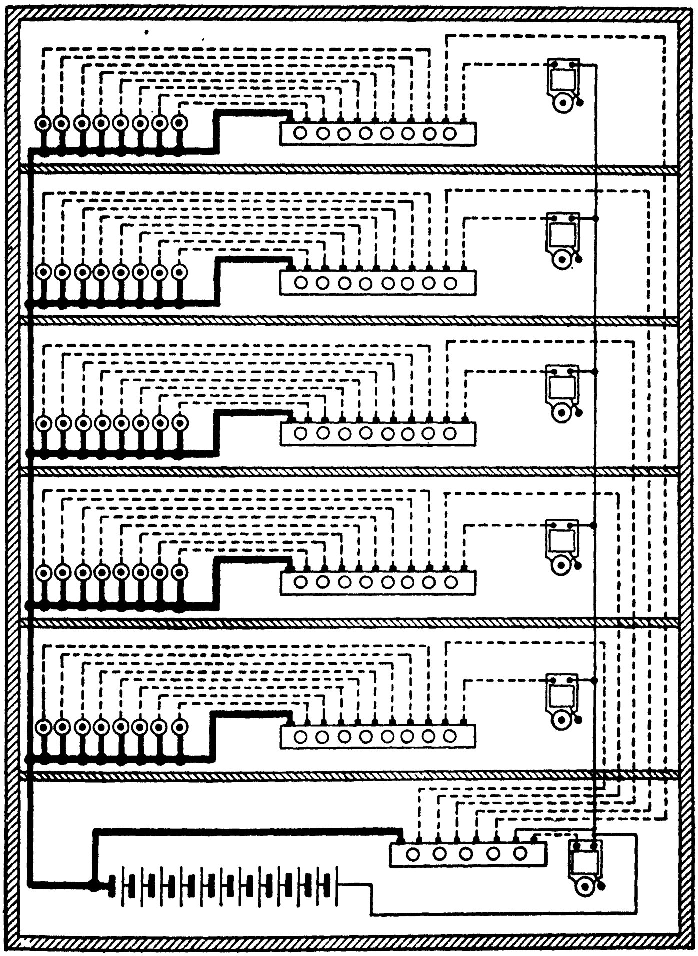


FIG. 233. PUSHES ON EACH FLOOR OF A BUILDING RING A BELL THROUGH A MECHANICAL-REPLACEMENT OR PENDULUM RELAY-INDICATOR ON THE SAME FLOOR

A similar indicator and bell in the housekeeper's room (or elsewhere) shows when and on what floor a call is made. One battery only.

¶ 5. Bell and Electrical-replacement Indicator Circuits

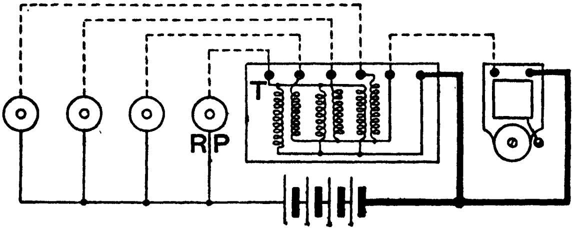


FIG. 234. BELL CIRCUIT USING ELECTRICAL REPLACEMENT CIRCUIT, RESET BY MEANS OF A SPECIAL PUSH

The pushes ring the bell through an electrical-replacement indicator. The movements are replaced by pressing the replacing push *RP*, which is connected to the terminal *T*.

Extra replacing pushes may be connected in parallel with *RP*.

One battery.

Fig. 235. An electrical-replacement relay-indicator and bell in the house-keeper's room (or elsewhere) shows when and on what floor a call is made.

When the movement of any indicator is replaced, a contact is made which actuates the replacing coil of the corresponding movement in the electrical-replacement indicator.

One battery only.

This arrangement, which is due to Messrs. Gent & Co., is a decided improvement on that in Fig. 233.

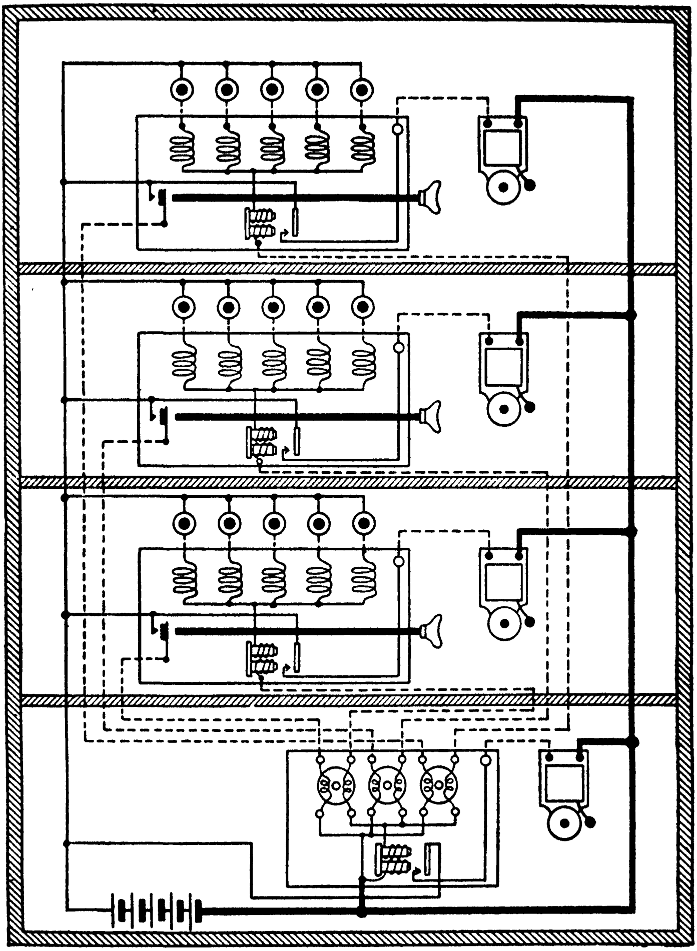


FIG. 235. A NUMBER OF PUSHES ON EACH FLOOR OPERATE A MECHANICAL-REPLACEMENT RELAY-INDICATOR AND BELL ON THE SAME FLOOR

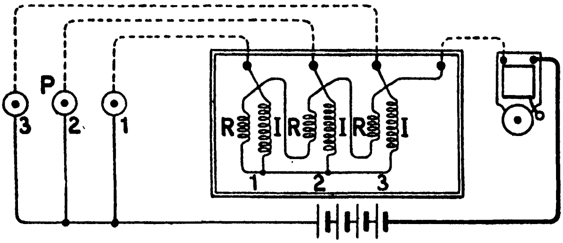


FIG. 236. BELL CIRCUIT USING INDICATOR OF AUTOMATIC RESETTING TYPE

The pushes *P* ring a bell through an electrical-self-replacing indicator.

When a push is pressed, the current flows through the corresponding indicating coil *I*, and then through *all* the replacing coils *R*, *R*, *R* in series. The indicating coils have more turns than the replacing coils, so that when the current flows through any given indicating coil, the latter overpowers the effect of the replacing coil of the same movement. Thus if, to start with, push No. 1 is pressed, the flag of movement No. 1 will be deflected and will remain so. Suppose next that No. 2 push is pressed, the flag of movement No. 2 will be deflected and that of movement No. 1 will be replaced, and so on. Thus a movement is not replaced until a call is made on another movement.

One battery only.

INDICATORS WITH LAMPS. In some indicators, miniature glow-lamps take the place of electro-magnetic movements; a break-circuit key being connected in series with each. Every push is fitted with a small hold-down magnet; and when a push is depressed, its magnet holds it so, and keeps the corresponding lamp alight. When the call is attended to, the circuit of the lighted lamp is momentarily broken at its key, and the push thereupon returns to its off position. When an indicator of this kind is fitted with a bell, which is not always the case, the bell should be connected through a relay.

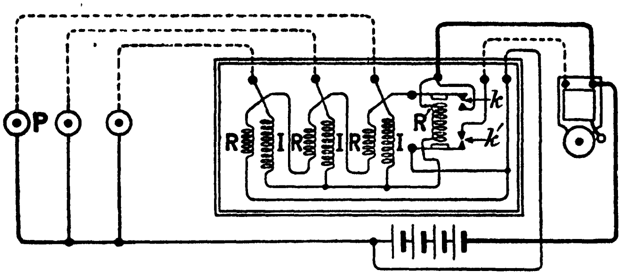


FIG. 237. INDICATOR WITH ELECTRICAL RESETTING OPERATED BY RELAY

The pushes *P* ring a bell through an electrical self-replacing relay-indicator.

As in the previous example, the indicating coils *I* are stronger than the replacing coils *R*, and when a call is made, the flag of the movement which was last deflected is replaced, unless the fresh call is made from the same push. The relay *R'* has two contacts *k* and *k'*. The former closes the replacing-coil circuit, and the latter the bell circuit.

One battery only.

This arrangement is a suggestion of the Author's, and the reasons should be obvious. Both in this case and in Fig. 236, when there are many replacing coils, it would be well to group them in parallel-series.

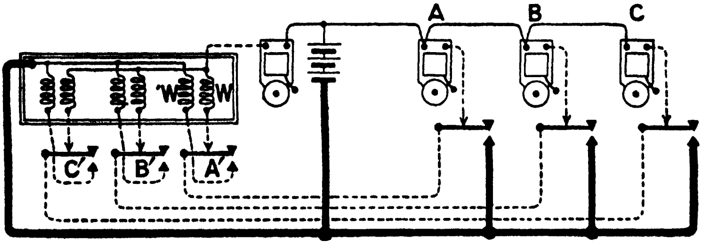


FIG. 238. MODIFIED ELECTRICAL REPLACEMENT INDICATOR CIRCUIT

Morse pushes at *A*, *B*, and *C* ring the distant bell through an electrical-replacement indicator. Each indicator movement has its own replacing (morse) push *A'*, *B'*, and *C'*; and when either of the latter is depressed, a reply signal is given on the corresponding bell at *A*, *B*, or *C*.

One battery only.

This arrangement should be compared with that in Fig. 227.

¶ 6. Alarm Circuits

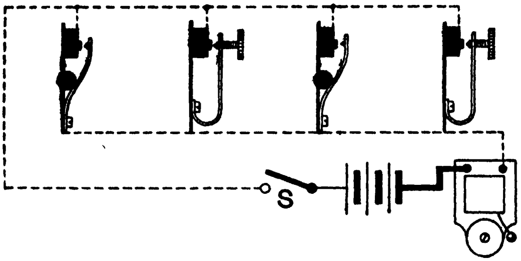


FIG. 239. FIRE AND BURGLAR ALARMS CONNECTED IN PARALLEL TO A BELL AND BATTERY

The circuit may be opened at the switch *S*.

In practice, the burglar alarms would be grouped on one circuit and the fire alarms on another; and indicators would sometimes be fitted to show from which part of the building the alarm had emanated.

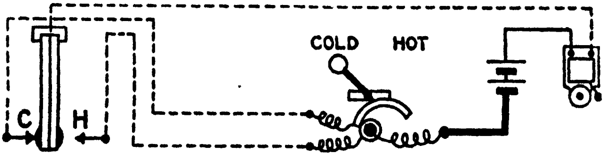


FIG. 240. HEAT AND COLD ALARM CONNECTED WITH A BELL, BATTERY, AND POLARISED INDICATOR-MOVEMENT

***CH*, alarm.**

If the bell be connected through a relay, as in Fig. 232, the action of the indicator movement will be more certain.

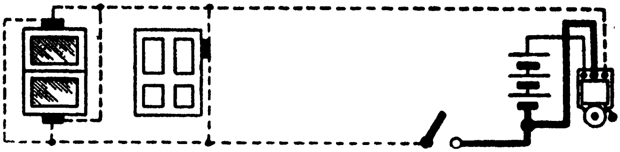


FIG. 241. BURGLAR ALARMS CONNECTED THROUGH A BATTERY AND SWITCH TO A CONTINUOUS-RINGING BELL

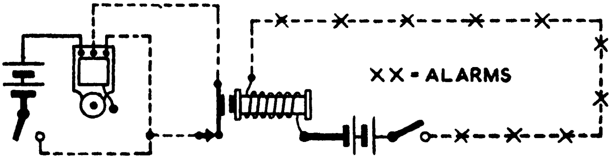


FIG. 242. CLOSED-CIRCUIT BURGLAR ALARMS CONNECTED THROUGH A SWITCH AND CONSTANT-CURRENT BATTERY TO A RELAY

When the alarm circuit is *broken*, the relay actuates a continuous-ringing bell from a local battery. A switch in the bell circuit enables it to be stopped.

One constant current battery and one ordinary battery.

Two or more alarm circuits and relays could be connected in parallel to one constant-current battery; and the relay-contact circuits connected through an indicator to the local battery and bell.

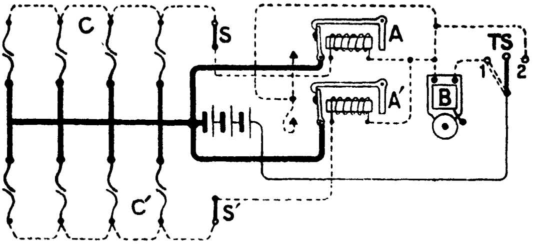


FIG. 243. BURGLAR ALARM CIRCUIT

Burglar-alarm contacts on two circuits *C* and *C′* actuate the bell *B* through the combined indicator-movements and drop-relays *A* or *A′* respectively, when the test switch *TS* is on its No. 1 contact.

The relay contacts keep the bell ringing until (presuming the alarm contact has opened again, or the switch *S* or *S′* has been opened) the shutter is replaced. Or the bell may be stopped by opening the switch *TS*. *S* and *S′* are open during the daytime.

The alarms may be tested, without ringing the bell, by placing *TS* on its No. 2 contact; then, if any of the alarms are closed, the corresponding indicator movement or movements will be actuated.

One battery only.

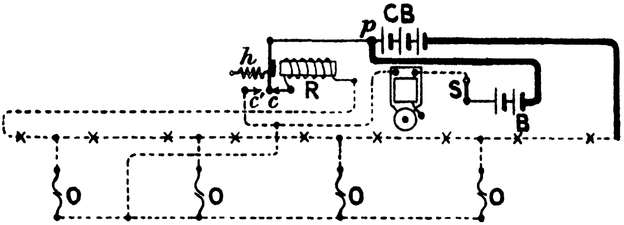


FIG. 244. COMBINED CLOSED- AND OPEN-CIRCUIT BURGLAR ALARM CIRCUITS

This figure shows closed- and open-circuit burglar contacts combined on one system. Here, *X*, *X*, *X* are the closed, and *O*, *O*, *O* the open-circuit alarms. The closed circuit is operated from the constant-current battery *CB*, the circuit including the high-resistance relay *R*. This circuit is set by pushing the relay armature up to its magnet, so completing the circuit at the contacts *c*: then, if all the alarms be closed, the magnet will hold on to the armature, and keep the contacts at *c* together. If, after this, any one of the alarms *X*, *X*, *X* be opened, the relay armature will be pulled back by a small helical spring *h*, and will then close the local circuit at *c'*; this circuit comprising the bell, switch *S*, and ordinary battery *B*. The bell is stopped by opening the switch *S*, which must be closed again when the alarm circuit has been set as described above. The fact that the two batteries are connected together at the point *p* does not affect their separate action. When, however, any one of the open-circuit alarms *O*, *O*, *O* is closed, while the circuit *X*, *X*, *X* is intact, *CB* and *B* act together in series and ring the bell direct, without affecting *R*, provided the spring *h* be not too strong.

One constant-current battery and one ordinary battery.

¶ 7. Simple Telephone Circuits

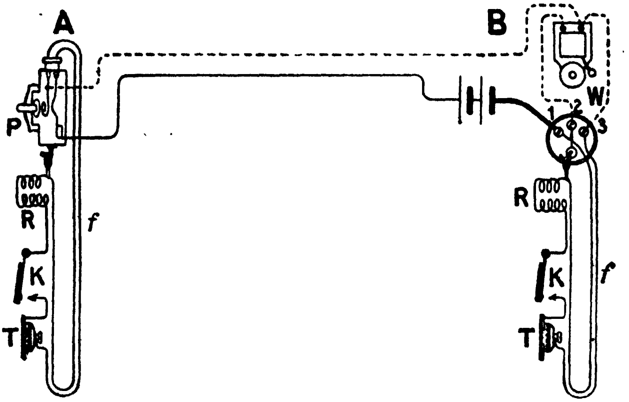


FIG. 245. SIMPLE TWO-STATION TELEPHONE CIRCUIT

This illustrates how hand-combination telephones (or transceivers) may be combined with a simple bell circuit. A push *P* with a two-pin socket replaces the ordinary push at *A*. At *B*, the wire which would ordinarily run from the bell to the battery is cut and connected to two of the terminals of a three-terminal rosette in the manner shown; an extra wire *W* being run from the bell to the other terminal. When the telephone hangs on the hook on this rosette, its metal eye makes contact therewith. The hook being connected to terminal 2, and the eye with that strand of the flexible cord *f* which is joined-up to terminal 1, it follows that 1 and 2 are directly connected when the telephone is in place, and the circuit so disposed that the bell may be rung. *T* is the microphone of the transmitter, *R* the magnet coils of the receiver, and *K* the key. The connection to the push is clearly shown at *P*.

By this arrangement *A* can signal to *B*, giving, say, two rings when it is desired to speak. When the telephones are lifted off their hooks, the circuit is as shown in Fig. 246, the bell and the push contacts being quite out of the circuit.

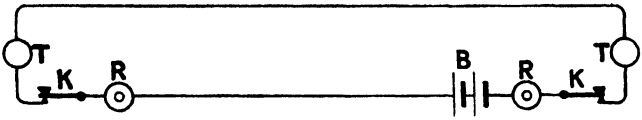


FIG. 246. KEY DIAGRAM OF TELEPHONE CIRCUIT

B, Battery.
K, *K*, Keys.
R, *R*, Telephone Receivers.
T, *T*, Telephone Transmitters (Microphone).

In some simple telephone circuits the bell is included, the telephone current being insufficient to cause the bell to work. In such a case the rosette has only two terminals, which are short-circuited when the 'phone is hung up. This arrangement is not satisfactory however, because the resistance and inductance of the bell magnet weaken the speaking currents.

In some instruments the hook on the rosette forms the end of a lever key or switch, which performs the necessary short-circuiting when the 'phone is hung on it. When the 'phone is lifted off, a spring draws the hook lever up, and open-circuits the terminals. In this case therefore, no connection is necessary through the eye of the 'phone.

One battery.

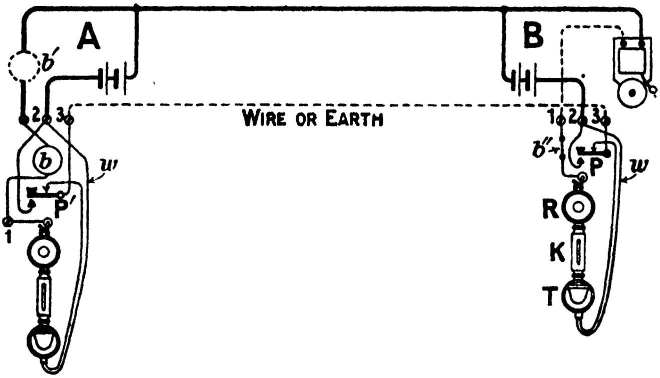


Fig. 247. Telephone Circuit calling either of Two Stations

When it is required so to connect two places *A* and *B* that either may ring up the other, the connections may be as in Fig. 247. Sometimes the rosette carries the bell, and sometimes the bell is separate. The first arrangement is shown at *A* and the latter at *B*; the difference being that the bell *b* at *A* would otherwise be connected in circuit where shown dotted at *b′*. Where the bell at *B* is not separate, it would be connected between the dots at *b″*, *i.e.*, in the same relative position as *b* at *A*. When either push is pressed, the bell is rung at the other station, and the latter can then give a reply ring.

When the telephones are on their hooks they short-circuit terminals 1 and 3, through the morse pushes *P* and *P′*; 1 at *A* being a point between the bell *b* and the hook.

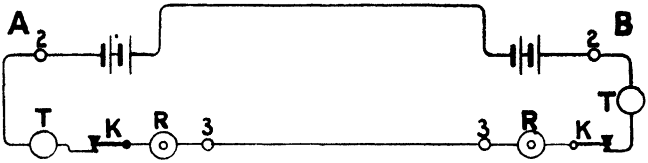


FIG. 248. KEY DIAGRAM TO FIG. 247

When the telephones are lifted off their hooks the circuit is as shown above. Here it is important to note that though each battery acts separately when ringing-up, both are included in the speaking circuit; it is therefore necessary to see that they are so connected as not to oppose each other. It should also be noted that the flexible conductor *w* (Fig. 247) from terminal 2 to the transceiver is that which is connected through the transmitter *T* to the key *K* (Fig. 248). There is thus no circuit that way unless the transceiver key be pressed down. If this be done while the telephone is hanging on its hook, a local circuit will be completed through the telephone and bell, but the current will probably not be strong enough to ring the bell.

Two batteries.

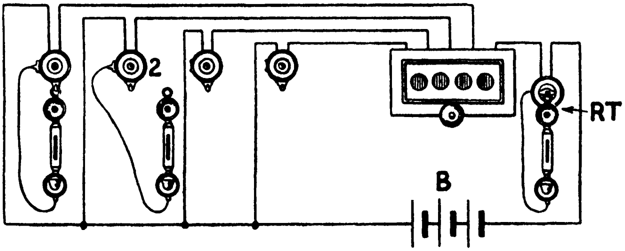


FIG. 249. ORDINARY METHOD OF COMBINING TRANSCEIVER TELEPHONES WITH BELL AND INDICATOR CIRCUITS

The pushes are similar to that at *P* in Fig. 245. The rosette to which the reply telephone *RT* is attached has only two terminals, which are short-circuited when *RT* is hung up. This short-circuiting is effected by using a hook-switch, or a fixed hook with the hook and telephone eye connected in circuit.

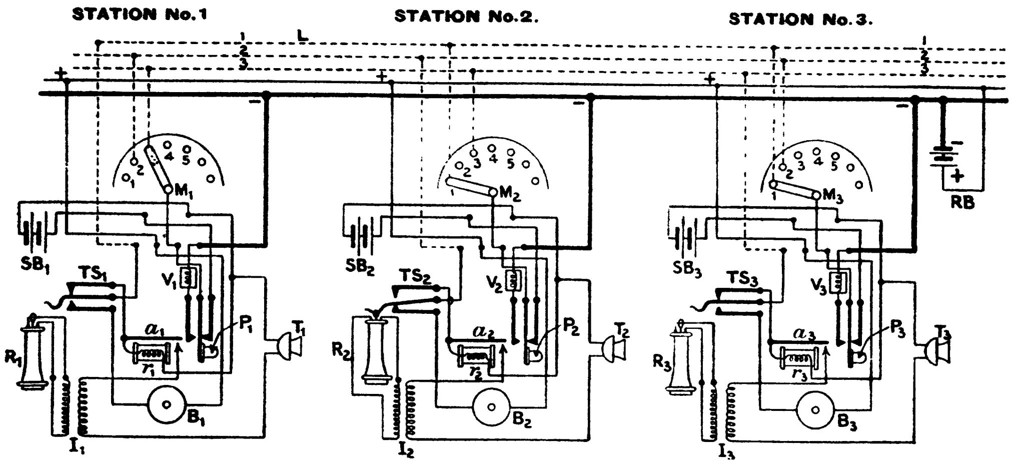


FIG. 250. INTERNAL AND EXTERNAL CONNECTIONS OF THREE STATIONS FITTED WITH PARSONS-SLOPER SECRET INTERCOMMUNICATION TELEPHONES

(*Gent & Co.*)

L = Line Wires.
M = Multiple-way Switch.
P = Push Button.
B = Call Bell.
V = Vibrator or "Tatler."
TS = Two-way Switch.
T = Transmitter.
R = Receiver.
SB = Speaking Battery.
I = Induction Coil.
r = Relay.
a = Relay Armature.
RB = Ringing Battery.

METHOD OF USE. Suppose in Fig. 251 Station 1 wishes to call up Station 3. *M*1 is moved to No. 3 stud, and *P*1 pressed. *V*1 will emit a humming sound if *B*3 rings. If *V*1 is silent when *P*1 is pressed, it means that Station 3 is conversing with some other station, *B*3 being consequently cut out of circuit. If *V*1 responds, *R*1 is lifted off its hook and held to the ear. At Station 3, when the call is received, *R*3 is lifted off its hook, and *M*3 moved slowly over its contacts until a click is heard in *R*3. This click is also heard in *R*1, and indicates that the speaking circuit is completed.

While stations 1 and 3 are conversing, it is impossible for any other station on the circuit either to interrupt or to overhear. Thus supposing station 2 turns its switch *M*2 to contact 1, as shown, and then depresses its push button *P*2; nothing will happen, as there is no complete circuit for the ringing battery *RB* through Station 1. If Station 2 takes off its receiver, it can hear nothing, as line 2 is disconnected at the other stations.

Any number of stations up to 20 or more may-be interconnected on this system.

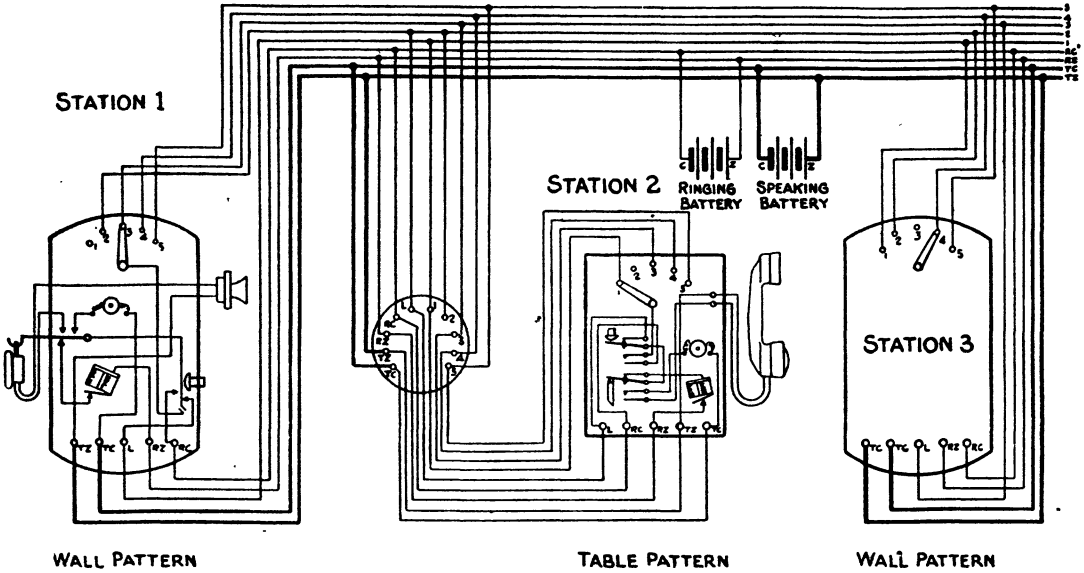


FIG. 251. DIAGRAM OF TYPICAL INTERCOMMUNICATION TELEPHONE CIRCUIT (*G.E.C.*)
Two stations can listen to a third.

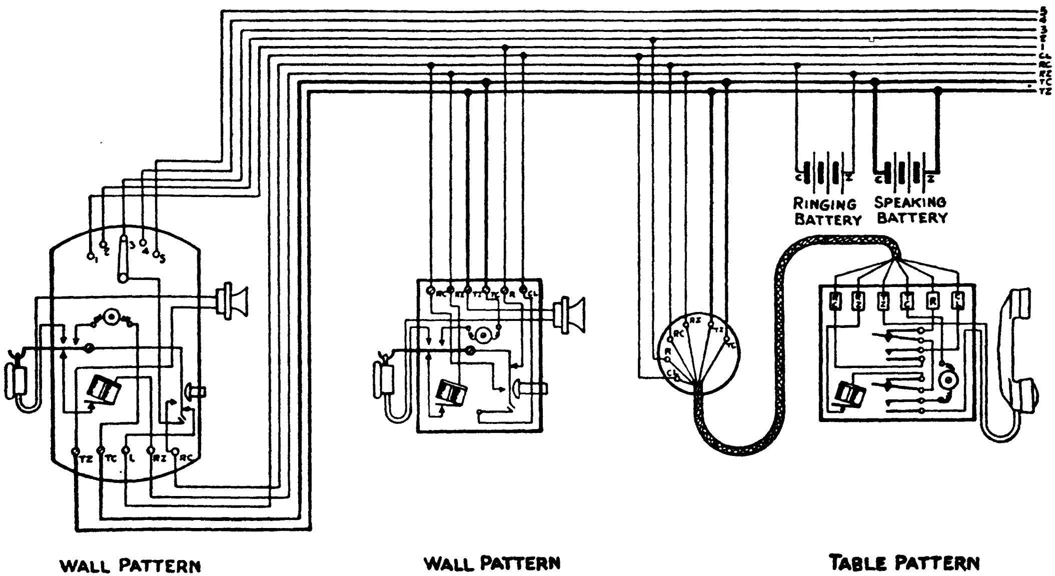


Fig. 252. Diagram of Typical Intercommunication Telephone Circuit (*G.E.C.*)

¶ 8. Electric Clock Circuits

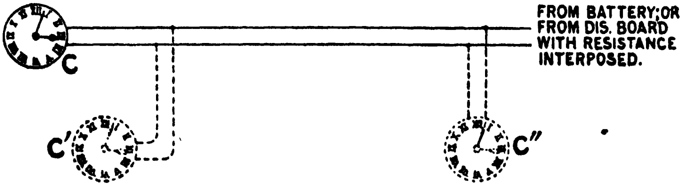

FROM BATTERY; OR FROM DIS. BOARD WITH RESISTANCE INTERPOSED.
C
C′
C″

Fig. 253. Connection of one or more Electrically-driven Clocks to a Source of Current

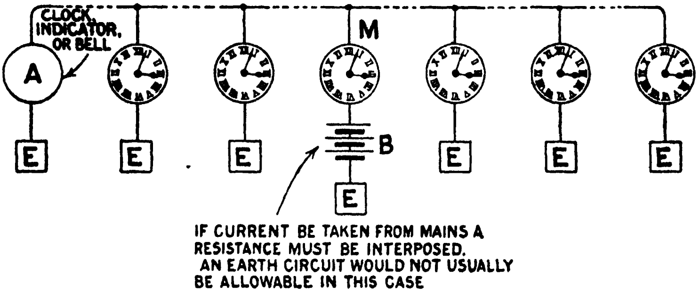

CLOCK, INDICATOR, OR BELL
A
M
B
E
E
E
E
E
E
E
E
IF CURRENT BE TAKEN FROM MAINS A RESISTANCE MUST BE INTERPOSED. AN EARTH CIRCUIT WOULD NOT USUALLY BE ALLOWABLE IN THIS CASE

Fig. 254. Electric Clock Circuit: Master Clock Supplied by Battery

M is a master synchronising clock which periodically (every hour, for instance) sends out synchronising currents which correct the self-driven clocks connected in the circuit.

The synchronising current may also be employed to actuate an indicating or detector needle or a bell, as at *A*.

One battery, or supply from distribution board.

Wire may be substituted for the earth returns.

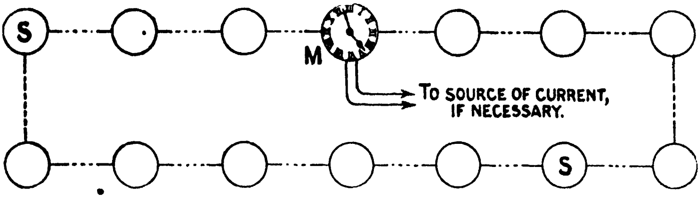


Fig. 255. Master Clock driving a number of Secondary Clocks in Series

M, master clock; *S*, *S*, secondary clocks.

In at least one system (the "Magneta") no battery or other external source of current is necessary, the master clock including the functions of a magneto-generator.

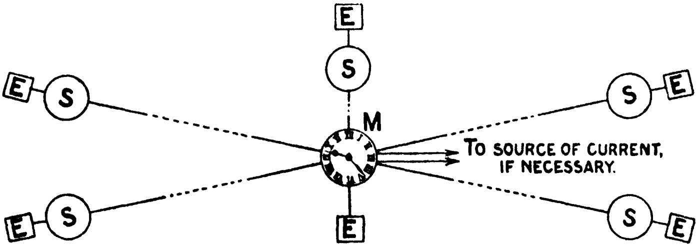


Fig. 256. Master Clock driving a number of Secondary Clocks in parallel

M, master clock; *S*, *S*, secondary clocks.

Wire may be substituted for the earth returns.

SECTION VI

TRANSFORMER LAYOUTS

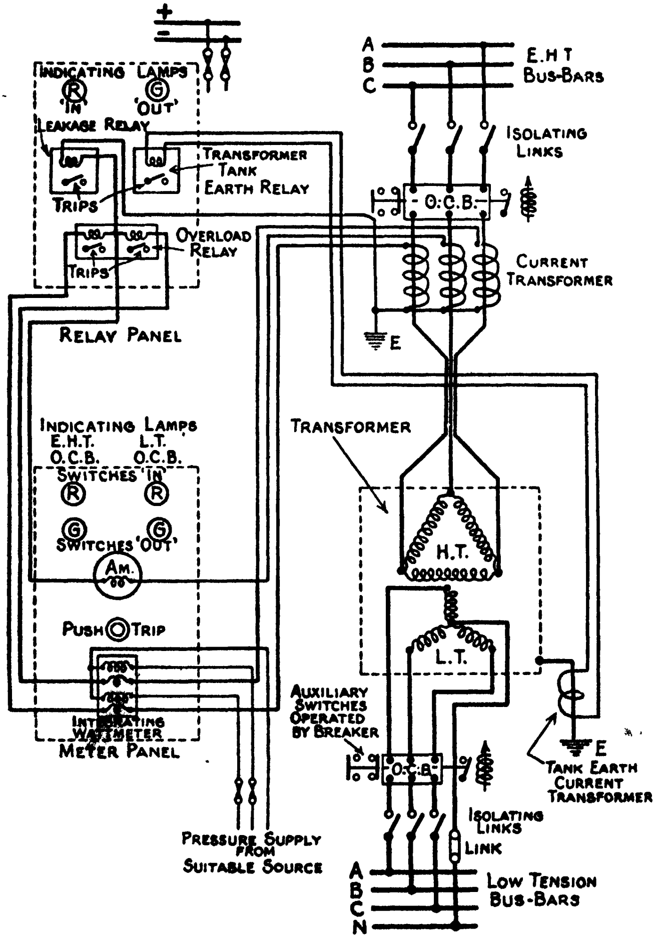


FIG. 257. TYPICAL WORKS TRANSFORMER LAYOUT
Showing l.t. a.c. meter and relay operating circuits only.

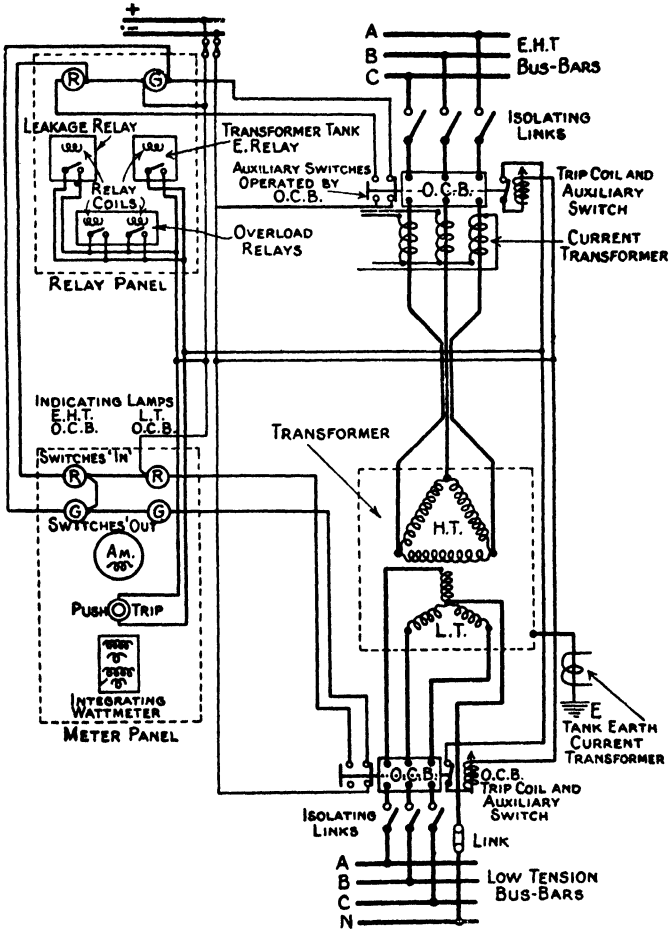


Fig. 258. Typical Works Transformer Layout

Showing switch, pilot lamps and protective relay tripping circuits only.

MADE IN GREAT BRITAIN AT THE PITMAN PRESS, BATH
C7—(T.5095)

FROM PITMAN'S LIST

Commercial Electrical Measuring Instruments

By R. M. Archer, B.Sc. (Lond.), A.R.C.Sc., M.I.E.E.

An introductory book on measuring instruments—particularly ammeters, voltmeters, and wattmeters—intended mainly for users of instruments who wish to obtain a general knowledge of their working without going exhaustively into the subject.

In crown 8vo, 260 pp., with 74 illustrations. **10s. 6d.** net.

A Dictionary of Electrical Terms

By S. R. Roget, M.A. (Cantab.), A.M.Inst.C.E., A.M.I.E.E.

A complete and up-to-date dictionary of electrical engineering terms in the English language.

In crown 8vo, cloth gilt, 404 pp. Second Edition. **7s. 6d.** net.

Electric Wiring Tables

By W. Perren Maycock, M.I.E.E. Sixth Edition. Revised by F. Charles Raphael, M.I.E.E.

A collection of original and carefully verified tables for the use of electrical engineers. The recent changes in the I.E.E. Wiring Rules and in the Standard Table of Copper Conductors are incorporated in this edition.

In waistcoat-pocket size. **3s. 6d.** net.

Electric Wiring of Buildings

By F. C. Raphael, M.I.E.E.

Deals with the various systems of wiring in common use, and explains the installation of wires in modern buildings to provide power, heat, and lighting. The book is suitable for architects, consultants, installation engineers, and students.

In crown 8vo, cloth gilt, 268 pp., illustrated. **10s. 6d.** net.

Electric Wiring, Fittings, Switches, and Lamps

By W. Perren Maycock, M.I.E.E.

A practical book for electric light engineers and contractors, consulting engineers, architects, builders, wiremen, and students.

In crown 8vo, with 628 illustrations, 646 pp. Sixth Edition, Revised by Philip Kemp, M.Sc., M.I.E.E. **10s. 6d.** net.

Power Wiring Diagrams

By A. T. Dover, M.I.E.E., A.Amer.I.E.E., *Head of the Electrical Engineering Department at the Battersea Polytechnic, London.*

A handbook of connection diagrams of control and protective systems for industrial C.C. and A.C. machines and apparatus. This book contains upwards of 200 carefully prepared diagrams of connections of electric power circuits, each diagram being accompanied by explanatory notes. It also contains a collection of useful data, curves, etc., relating to starters and protective apparatus. The size of the book is such that it can be conveniently carried in the pocket.

In pocket size (6¼ in. by 4 in.), foolscap 8vo, cloth, rounded edges, with 257 illustrations. Second Edition, Revised. **6s.** net.

Sir Isaac Pitman & Sons, Ltd. Parker St. Kingsway, London, W.C.2

An Abridged List of
TECHNICAL BOOKS

PUBLISHED BY
Sir Isaac Pitman & Sons, Ltd.
Parker Street, Kingsway, London, W.C.2

The prices given apply only to Great Britain

A complete Catalogue giving full details of the following books will be sent post free on application

---

CONTENTS

	PAGE
Art and Craft Work, etc.	2
Artistic Craft Series .	2
Aviation . . .	10
Civil Engineering, Building, etc. . . .	7, 8
Common Commodities and Industries Series	.21–23
Draughtsmanship . .	4
Electrical Engineering, etc. . . .	.12–15
Foundrywork and Metallurgy . . .	5, 6
Mathematics and Calculations for Engineers	. 16, 17
Mechanical Engineering	8, 9
Mineralogy and Mining .	6, 7
Miscellaneous Technical Books	18
Motor Engineering, etc..	11
Optics and Photography	.11, 12
Physics, Chemistry, etc. .	4, 5
Technical Primers .	.19, 20
Telegraphy, Telephony, and Wireless .	.15, 16
Textile Manufacture, etc. . . .	3

C5—11

ALL PRICES ARE NET, EXCEPT THOSE MARKED *

THE ARTISTIC CRAFT SERIES

	s.	d.
Bookbinding and the Care of Books. By Douglas Cockerell. Fourth Edition	7	6
Dress Design. By Talbot Hughes	12	6
Embroidery and Tapestry Weaving. By Mrs. A. H. Christie. Fourth Edition	10	6
Hand-Loom Weaving. By Luther Hooper	10	6
Heraldry. By Sir W. H. St. John Hope, Litt.D., D.C.L.	12	6
Silverwork and Jewellery. By H. Wilson. Second Edition	10	6
Stained Glass Work. By C. W. Whall	10	6
Wood-Block Printing. By F. Morley Fletcher	8	6
Woodcarving Design and Workmanship. By George Jack. Second Edition	8	6
Writing and Illuminating and Lettering. By Edward Johnston. Seventeenth Impression	8	6

ART AND CRAFT WORK, ETC.

	s.	d.
Block-Cutting and Print-Making by Hand. By Margaret Dobson, A.R.E.	12	6
Cabinet-Making, The Art and Craft of. By D. Denning	5	0
Draw Loom, The New. By Luther Hooper.	25	0
Hand-Block Printing on Fabrics. By T. J. Corbin, A.R.C.A.	5	0
Leather Craft. Artistic. By Herbert Turner	5	0
Leather Work: Stamped, Moulded, Cut, Cuir-Bouilli, Sewn, etc. By Charles G. Leland. Third Edition	5	0
Lettering, Decorative Writing and Arrangement of. By Prof. A. Erdmann and A. A. Braun. Second Edition	10	6
Lettering from A to Z, Modern. By A. Cecil Wade	12	6
Lettering, Plain and Ornamental. By Edwin G. Fooks	3	6
Manuscript and Inscription Letters. By Edward Johnston	7	6
Manuscript Writing and Lettering. By an Educational Expert.	6	0
Plywood and Glue, Manufacture and Use of. By B. C. Boulton, B.Sc.	7	6
Pottery, Handcraft. By H. and D. Wren	12	6
Stencil-Craft. By Henry Cadness, F.S.A.M.	10	6
Weaving for Beginners. By Luther Hooper	5	0
Weaving with Small Appliances—		
The Weaving Board. By Luther Hooper	7	6
Table Loom Weaving. By Luther Hooper	7	6
Tablet Weaving. By Luther Hooper	7	6
Wood Carving. By Charles G. Leland. Revised by John J. Holtzapffel	5	0
Woodcarving, Handicraft of. By James Jackson	4	0
Wood Engraving Since Eighteen-Ninety. By Bernard Sleigh, R.B.S.A.	21	0
Woodwork Design. By E. H. Arnold	6	0

TEXTILE MANUFACTURE, ETC.

	s.	*d.*
Artificial Silk and Its Manufacture. By Joseph Foltzer. Translated into English by T. Woodhouse. Fourth Edition	21	0
Artificial Silk. By Dr. V. Hottenroth. Translated from the German by Dr. E. Fyleman, B.Sc.	30	0
Artificial Silk. By Dr. O. Faust	10	6
Bleaching, Dyeing, Printing, and Finishing for the Manchester Trade. By J. W. McMyn, F.C.S., and J. W. Bardsley. Second Edition	6	0
Cotton, from the Raw Material to the Finished Product. By R. J. Peake, Revised and Enlarged by H. P. Curtis, F.T.I.	5	0
Cotton Spinner's Pocket Book, The. By J. F. Innes. 3rd Ed.	3	6
*Cotton Spinning Course, A First Year. By H. A. J. Duncan, A.T.I.	3	6
Flax and Jute, Spinning, Weaving, and Finishing of. By T. Woodhouse, F.T.I.	10	6
Flax Culture and Preparation. By F. Bradbury. 2nd Ed.	10	6
Fur. By Max Bachrach, B.C.S.	21	0
Hosiery Manufacture. By Professor William Davis, M.A. Second Edition	5	0
Knitted Fabrics, Calculations and Costings for. By Professor William Davis, M.A.	10	6
Loom, Theory and Electrical Drive of the. By R. H. Wilmot, M.Sc., A.M.I.E.E., Assoc. A.I.E.E.	8	6
Men's Clothing, Organization, Management, and Technology in the Manufacture of. By M. E. Popkin	25	0
Pattern Construction, The Science of. For Garment Makers. By B. W. Poole	45	0
Tailoring, Practical. By J. E. Liberty, U.K.A.F.	7	6
Textile Educator, Pitman's. Edited by L. J. Mills. 3 Vols.	63	0
*Textiles, Introduction to. By A. E. Lewis, A.M.C.T.	3	6
Textiles Student's Manual, The. By T. Welford	7	6
Textiles for Salesmen. By E. Ostick, M.A., L.C.P. 2nd Ed.	5	0
Towels and Towelling, the Design and Manufacture of. By T. Woodhouse, F.T.I., and A. Brand, A.T.I.	12	6
Weaving and Manufacturing, Handbook of. By H. Greenwood, F.T.I., M.R.S.T.	5	0
Wool, The Marketing of. By A. F. DuPlessis, M.A.	12	6
Woollen Yarn Production. By T. Lawson	3	6
Wool Substitutes. By Roberts Beaumont, M.Sc.	10	6
Worsted Carding and Combing. By J. R. Hind, M.R.S.T.	7	
Worsted Open Drawing. By S. Kershaw, F.T.I.	5	0
Yarns and Fabrics, The Testing of. By H. P. Curtis, F.T.I. Second Edition	5	0

DRAUGHTSMANSHIP

	s.	d.
Drawing and Designing. By Charles G. Leland, M.A. 4th Ed.	3	6
Drawing Office Practice. By H. Pilkington Ward, M.Sc., A.M.Inst.C.E.	7	6
Engineer Draughtsmen's Work. By A Practical Draughtsman	2	6
Engineering Design, Examples in. By G. W. Bird, B.Sc. Second Edition	6	0
*Engineering Drawing, A First Year. By A. C. Parkinson, A.C.P. (Hons.), F.Coll.H. Second Edition	5	0
Engineering Hand Sketching and Scale Drawing. By Thos. Jackson, M.I.Mech.E., and Percy Bentley, A.M.I.Mech.E.	3	0
*Engineering Workshop Drawing, By A. C. Parkinson, A.C.P. (Hons.), F.Coll.H. Third Edition	4	0
*Machine Drawing, A Preparatory Course to. By P. W. Scott	2	0
Plan Copying in Black Lines. By B. J. Hall, M.I.Mech.E.	2	6

PHYSICS, CHEMISTRY, ETC.

Artificial Resins. By J. Scheiber, Ph.D. Translated by Ernest Fyleman, B.Sc., Ph.D., F.I.C.	30	0
Biology, Introduction to Practical. By N. Walker	5	0
*Botany, Test Papers in. By E. Drabble, D.Sc.	2	0
Chemical Engineering, An Introduction to. By A. F. Allen, B.Sc. (Hons.), F.C.S., LL.B.	10	6
*Chemistry, A First Book of. By A. Coulthard, B.Sc. (Hons.), Ph.D., F.I.C.	2	0
Chemistry Course for Painters and Decorators. By P. F. R. Venables, Ph.D., B.Sc., and H. C. Utley, F.I.B.D.	3	6
*Chemistry, Definitions and Formulae for Students. By W. G. Carey, F.I.C.	–	6
*Chemistry, Higher Test Papers in. By E. J. Holmyard, M.A. 1. Inorganic. 2. Organic *Each*	3	0
Chemistry, Practical Pharmaceutical. By J. W. Cooper, Ph.C., and F. N. Appleyard, B.Sc. Second Edition.	5	0
*Chemistry, Test Papers in. By E. J. Holmyard, M.A.	2	0
With Points Essential to Answers	3	0
Dispensing for Pharmaceutical Students. By J. W. Cooper and F. J. Dyer. Fourth Edition, Revised and Re-written by J. W. Cooper	7	6
Electricity and Magnetism, First Book of. By W. Perren Maycock, M.I.E.E. Fourth Edition	6	0
Engineering Principles, Elementary. By G. E. Hall, B.Sc.	2	6
*Latin for Pharmaceutical Students. By J. W. Cooper and A. C. McLaren. Second Edition.	6	0
*Light and Sound, Definitions and Formulae for Students. By P. K. Bowes, M.A., B.Sc.	–	6
*Magnetism and Electricity, Higher Test Papers in. By P. J. Lancelot Smith, M.A.	3	0

Physics, Chemistry, etc.—contd.

	s.	d.
Magnetism and Electricity, Questions and Solutions in. Solutions by W. J. White, A.M.I.E.E. Third Edition	5	0
Organic Pigments, Artificial. By Dr. C. A. Curtis. Translated by Ernest Fyleman, B.Sc., Ph.D., F.I.C.	21	0
Pharmacognosy, Textbook of. Part I—Practical. By J. W. Cooper, Ph.C., T. C. Denston, B.Pharm., Ph.C., and M. Riley, A.M.C.	10	6
Pharmacy, A Course in Practical. By J. W. Cooper, Ph.C., and F. N. Appleyard, B.Sc., F.I.C., Ph.C. Second Edition	7	6
***Physical Science, Primary.** By W. R. Bower, B.Sc.	3	6
***Physics, Test Papers in.** By P. J. Lancelot-Smith, M.A.	2	0
Points Essential to Answers, 4s. In one book	5	6
Tutorial Pharmacy (Being Second Edition of *Pharmacy, General and Official*). By J. W. Cooper, Ph.D.	10	6
Volumetric Analysis. By J. B. M. Coppock, Ph.D., B.Sc., A.I.C., and J. B. Coppock, B.Sc. (Lond.), F.I.C., F.C.S. Third Edition	3	6
***Volumetric Work, A Course of.** By E. Clark, B.Sc.	4	6

FOUNDRYWORK AND METALLURGY

	s.	d.
Aluminium and its Alloys. By N. F. Budgen, Ph.D., M.Sc., B.Sc. (Hons.)	15	
Ball and Roller Bearings, Handbook of. By A. W. Macaulay, A.M.I.Mech.E.	7	6
***Definitions and Formulae for Students—Metallurgy** By E. R. Taylor, A.R.S.M., F.I.C., D.I.C.	–	6
Electroplating. By S. Field and A. Dudley Weill	5	0
Electroplating with Chromium, Copper, and Nickel. By Benjamin Freeman, Ph.D., and Frederick G. Hoppe	21	0
Engineering Materials. By A. W. Judge, Wh.Sc., A.R.C.S. In three volumes—		
Vol. I. Ferrous	30	0
Vol. II. Non-Ferrous	40	0
Vol. III. Theory and Testing of Materials	21	0
Engineering Workshop Exercises. By Ernest Pull, A.M.I.Mech.E., M.I.Mar.E. Second Edition, Revised	3	6
Files and Filing. By Ch. Fremont. Translated into English under the supervision of George Taylor	21	0
Foundrywork and Metallurgy. Edited by R. T. Rolfe, F.I.C. In six volumes *Each*	6	0
Ironfounding, Practical. By J. Horner, A.M.I.M.E. Fifth Edition. Revised by Walter J. May	10	0
Iron Rolls, The Manufacture of Chilled. By A. Allison	8	6
Metal Turning. By J. Horner, A.M.I.M.E. Fourth Edition	6	0
Metal Work for Craftsmen. By G. H. Hart and Golden Keeley, A.M.Inst.B.E., M.Coll.H.	7	6
Metal Work, Practical Sheet and Plate. By E. A. Atkins, A.M.I.M.E. Third Edition, Revised and Enlarged	7	6

Foundrywork and Metallurgy—contd.

	s.	d.
Metallographers' Handbook of Etching. Compiled by Torkel Berglund. Translated from the Swedish by W. H. Dearden, M.Sc., A.I.C.	12	6
Metallurgy of Bronze. By H. C. Dews	12	6
Metallurgy of Cast Iron. By J. E. Hurst	15	0
Pattern Making. The Principles of. By J. Horner, A.M.I.M.E. Fifth Edition	4	0
Pipe and Tube Bending and Jointing. By S. P. Marks, M.S.I.A.	6	0
Pyrometers. By E. Griffiths, D.Sc.	7	6
Special Steels. Chiefly founded on the Researches regarding Alloy Steels of Sir Robert Hadfield, Bt., D.Sc., etc. Second Edition. By T. H. Burnham, B.Sc. Hons. (Lond.), A.M.I.Mech.E., M.I.Mar.E.	12	6
Steel Works Analysis. By J. O. Arnold, F.R.S., and F. Ibbotson. Fourth Edition, thoroughly revised	12	6
Welding, Electric. By L. B. Wilson	5	0
Welding, Electric Arc and Oxy-Acetylene. By E. A. Atkins, M.I.Mech.E., etc. Second Edition	7	6
Welding, Electric, The Principles of. By R. C. Stockton, A.I.M.M., A.M.C.Tech.	7	6
Workshop Gauges and Measuring Appliances. By L. Burn, A.M.I.Mech.E., A.M.I.E.E.	5	0

MINERALOGY AND MINING

	s.	d.
Blasting with High Explosives. By W. Gerard Boulton	5	0
Coal Carbonization. By John Roberts, D.I.C., M.I.Min.E., F.G.S.	25	0
Coal Carbonization, International. By John Roberts, D.I.C., M.I.Min.E., F.G.S., and Dr. Adolf Jenkner	35	0
*Coal Mining, Definitions and Formulae for Students. By M. D. Williams, F.G.S.	–	6
Colliery Electrical Engineering. By G. M. Harvey. Second Edition	15	0
Electrical Engineering for Mining Students. By G. M. Harvey, M.Sc., B.Eng., A.M.I.E.E.	5	0
Electricity Applied to Mining. By H. Cotton, M.B.E., D.Sc., A.M.I.E.E.	35	0
Electric Mining Machinery. By Sydney F. Walker, M.I.E.E. M.I.M.E., A.M.I.C.E., A.Amer.I E.E.	15	0
Low Temperature Distillation. By S. North and J. B. Garbe	15	0
Mining Certificate Series, Pitman's. Edited by John Roberts, D.I.C., M.I.Min.E., F.G.S.		
Mining Law and Mine Management. By Alexander Watson, A.R.S.M.	8	6
Mine Ventilation and Lighting. By C. D. Mottram, B.Sc.	8	6

Mineralogy and Mining—contd.

	s.	d.
Mining Certificate Series—*contd.*		
Colliery Explosions and Recovery Work. By J. W. Whitaker, Ph.D. (Eng.), B.Sc., F.I.C., M.I.Min.E.	8	6
Arithmetic and Surveying. By R. M. Evans, B.Sc., F.G.S., M.I.Min.E.	8	6
Mining Machinery. By T. Bryson, A.R.T.C., M.I.Min.E.	12	6
Winning and Working. By Prof. Ira C. F. Stratham, B.Eng., F.G.S., M.I.Min.E.	21	0
Mining Science, A Junior Course in. By Henry G. Bishop.	2	6
Tin Mining. By C. G. Moor, M.A.	8	6

CIVIL ENGINEERING, BUILDING, ETC.

	s.	d.
Architectural Hygiene; or, Sanitary Science as Applied to Buildings. By Sir Bannister Fletcher, M.Arch. (Ireland), F.S.I., *Barrister-at-Law,* and Major H. Phillips Fletcher, D.S.O., F.R.I.B.A., F.S.I., etc. Sixth Edition	10	6
Architectural Practice and Administration. By H. Ingham Ashworth, B.A., A.R.I.B.A.	12	6
Audel's Masons' and Builders' Guides. In four volumes *Each*	7	6
Audel's Plumbers' and Steam Fitters' Guides. Practical Handbooks in four volumes *Each*	7	6
Brickwork, Concrete, and Masonry. Edited by T. Corkhill, M.I.Struct.E. In eight volumes *Each*	6	0
*Building, Definitions and Formulae for Students. By T. Corkhill, F.B.I.C.C., M.I.Struct.E.	–	6
Building Educator, Pitman's. Edited by R. Greenhalgh, A.I.Struct.E. In three volumes. Second Edition	72	0
Building Encyclopaedia, A Concise. Compiled by T. Corkhill, M.I.Struct.E.	7	6
Building, Mechanics of. By Arthur D. Turner, A.C.G.I., A.M.I.C.E.	5	0
Engineering Equipment of Buildings. By A. C. Pallot, B.Sc. (Eng.)	15	0
Geometry, Contour. By Alex. H. Jameson, M.Sc., M.Inst.C.E.	7	6
Hydraulics. By E. H. Lewitt, B.Sc. (Lond.), A.M.I.M.E. Fourth Edition	10	6
Joinery & Carpentry. Edited by R. Greenhalgh, A.I.Struct.E. In six volumes *Each*	6	0
Painting and Decorating. Edited by C. H. Eaton, F.I.B.D. In six volumes *Each*	7	6
Plastering. (Reprinted from *Brickwork, Concrete, and Masonry*). By W. Verrall, C.R.P.	2	0

Civil Engineering, Building, etc.—contd.

	s.	d.
Plumbing and Gasfitting. Edited by Percy Manser, R.P., A.R.S.I. In seven volumes . . . . *Each*	6	0
Reinforced Concrete, Construction in. By G. P. Manning, M.Eng., A.M.I.C.E.	7	6
Reinforced Concrete. By W. Noble Twelvetrees, M.I.M.E., A.M.I.E.E.	21	0
Reinforced Concrete Members, Simplified Methods of Calculating. By W. Noble Twelvetrees. Second Edition,	5	0
Specifications for Building Works. By W. L. Evershed, F.S.I.	5	0
Structures, The Theory of. By H. W. Coultas, M.Sc., A.M.I.Struct.E., A.I.Mech.E.	15	0
Surveying, Advanced. By Alex. H. Jameson, M.Sc., M.Inst.C.E.	12	6
Surveying, Tutorial Land and Mine. By Thomas Bryson	10	6
Water Mains, Lay-out of Small. By H. H. Hellins, M.Inst.C.E.	7	6
Water Supply Problems and Developments. By W. H. Maxwell, A.M.Inst.C.E.	21	0
Waterworks for Urban and Rural Districts. By H. C. Adams, M.Inst.C.E., M.I.M.E., F.S.I. Second Edition	15	0

MECHANICAL ENGINEERING

	s.	d.
Automatic Protective Gear for A.C. Supply Systems. By J. Henderson, M.C., B.Sc., A.M.I.E.E.	7	6
Condensing Plant. By R. J. Kaula, M.I.E.E., and I. V. Robinson, M.I.E.E.	30	0
*Definitions and Formulae for Students—Applied Mechanics. By E. H. Lewitt, B.Sc., A.M.I.Mech.E.	–	6
*Definitions and Formulae for Students—Heat Engines. By A. Rimmer, B.Eng. Second Edition	–	6
*Definitions and Formulae for Students, Marine Engineering. By E. Wood, B.Sc.	–	6
Diesel Engines: Marine, Locomotive, and Stationary. By David Louis Jones	21	0
Engineering Educator, Pitman's. Edited by W. J. Kearton, M.Eng., A.M.I.Mech.E., A.M.Inst.N.A. In three volumes. Second Edition	63	0
*Engineering, Introduction to. By R. W. J. Pryer, B.Sc. (Eng.), A.M.I.Mech.E., A.M.I.A.E.	2	0
*Engineering Science, Experimental. By Nelson Harwood, B.Sc., A.M.I.Mech.E.	7	6
First Year Engineering Science, Mechanical and Electrical. By G. W. Bird, Wh.Ex., A.M.I.Mech.E., etc.	5	0
Friction Clutches. By R. Waring-Brown, A.M.I.A.E., F.R.S.A., M.I.P.E.	5	0
Fuel Economy in Steam Plants. By A. Grounds, B.Sc., A.I.C., F.Inst.P.	5	0

Mechanical Engineering—contd.

	s.	*d.*
Fuel Oils and Their Applications. By H. V. Mitchell, F.C.S., M.Inst.P.Tech. Second Edition Revised by Arthur Grounds, B.Sc., A.I.C., F.Inst.P.	5	0
Mechanical Engineering Detail Tables. By J. P. Ross	7	6
Mechanical Engineers, Estimating for. By L. E. Bunnett, A.M.I.P.E.	10	6
Mechanical Engineer's Pocket Book, Whittaker's. Third Edition, entirely rewritten and edited by W. E. Dommett, A.F.Ae.S., A.M.I.A.E.	12	6
Mechanics' and Draughtsmen's Pocket Book. By W. E. Dommett, Wh.Ex., A.M.I.A.E.	2	6
Mechanics of Materials, Experimental. By H. Carrington, M.Sc. (Tech.), D.Sc., M.Inst.Met., A.M.I.Mech.E.	3	6
*Mechanics for Engineering Students. By G. W. Bird, B.Sc., A.M.I.Mech.E. Second Edition	5	0
Mollier Steam Tables and Diagrams, The. English Edition adapted and amplified from the Third German Edition by H. Moss, D.Sc., A.R.C.S., D.I.C.	7	6
Mollier Steam Diagrams. Separately in envelope	2	0
Motive Power Engineering. By Henry C. Harris, B.Sc.	10	6
Pulverized Fuel Firing. By Sydney H. North, M.Inst.F.	7	6
Second Year Engineering Science, Mechanical. By G. W. Bird, Wh.Ex., B.Sc., A.M.I.Mech.E., etc.	5	0
Steam Condensing Plant. By John Evans, M.Eng., etc.	7	6
Steam Plant, The Care and Maintenance of. By J. E. Braham, B.Sc., A.C.G.I.	5	0
Steam Turbine Operation. By W. J. Kearton, M.Eng., A.M.I.Mech.E., A.M.Inst.N.A.	12	6
Steam Turbine Theory and Practice. By W. J. Kearton, M.Eng., A.M.I.M.E., A.M.Inst.N.A. Third Edition	15	0
Strength of Materials. By F. V. Warnock, Ph.D., B.Sc. (Lond.), F.R.C.Sc.I., A.M.I.Mech.E.	12	6
Textile Mechanics and Heat Engines. By Arthur Riley, M.Sc.(Tech.), B.Sc., A.M.I.Mech.E., and Edward Dunkerley	15	0
Theory of Machines. By Louis Toft, M.Sc.Tech., and A. T. J. Kersey, A.R.C.Sc. Second Edition.	12	6
Thermodynamics, Applied. By Prof. W. Robinson, M.E., M.Inst.C.E.	18	0
Thermodynamics Applied to Heat Engines. By E. H. Lewitt, B.Sc., A.M.I.Mech.E.	12	6
Turbo-Blowers and Compressors. By W. J. Kearton, M.Eng., A.M.I.M.E., A.M.Inst.N.A.	21	0
Two-Cycle Engine, The. By C. F. Caunter	15	0
Uniflow, Back-pressure, and Steam Extraction Engines. By Eng. Lieut.-Com. T. Allen, R.N.(S.R.), M.Eng., etc.	42	0
Workshop Practice. Edited by E. A. Atkins, M.I.Mech.E., **M.I.W.E. In eight volumes** *Each*	6	0

AVIATION

	s.	d.
An Introduction to Aeronautical Engineering.		
Vol. I. Mechanics of Flight. By A. C. Kermode. A.F.R.Ae.S. Second Edition	8	6
Vol. II. Structures. By J. D. Haddon, B.Sc., A.F.R.Ae.S. Second Edition	6	0
Vol. III. Properties and Strength of Materials. By J. D. Haddon, B.Sc., A.F.R.Ae.S.	8	6
Aerobatics. By Major O. Stewart, M.C., A.F.C.	5	0
Aeronautics, The Handbook of. Published under the Authority of the Council of the Royal Aeronautical Society		
Vol. I. Second Edition	25	0
Vol. II. Aero-Engines, Design and Practice. By Andrew Swan, B.Sc., A.M.I.C.E., A.F.R.Ae.S. Second Edition	15	0
*Aeronautics, Definitions and Formulae for Students. By J. D. Frier, A.R.C.Sc., D.I.C.	-	6
Air Annual of the British Empire, 1934–35. Edited by Squadron-Leader Burge, O.B.E., A.R.Ae.S.I., A.Inst.T. Volume VI	21	0
Aircraft Performance Testing. By S. Scott Hall, M.Sc., D.I.C., etc., and T. H. England, D.S.C., A.F.C., etc.	15	0
Air Licences. By T. Stanhope Sprigg	3	6
Airman's Year Book, 1934–35, The. Edited by Squadron-Leader C. G. Burge, O.B.E., A.R.Ae.S.I., A.Inst.T.	3	6
Air Navigation for the Private Owner. By Frank A. Swoffer, M.B.E. Revised Edition	7	6
Aircraft Construction, Metal. By M. Langley, A.M.I.N.A., etc. Second Edition	15	0
Airmanship. By John McDonough, A.M.I.Mech.E.	7	6
Airsense. By W. O. Manning, F.R.Ae.S.	3	6
Autogiro, and How to Fly it. By Reginald Brie. Second Edition.	5	0
Flying as a Career. By Major Oliver Stewart, M.C., A.F.C.	3	6
Ground Engineer's Textbooks		
Vol. I. Aero Engines "C" and "D" Licences. By R. F. Barlow and A. N. Barrett	3	6
Vol. II. Instruments. "X" Licence. By R. W. Sloley, M.A. (Camb.) B.Sc. (Lond.)	5	0
Vol. III. The Rigging, Maintenance and Inspection of Aircraft "A" Licence. By W. J. C. Speller	5	0
Vol. IV. Inspection of Aircraft after Overhauls. "B" Licence. By S. J. Norton, Assoc.M.Inst.C.E., A.F.R.Ae.S.	3	6
Vol. V. Electrical and Wireless Equipment of Aircraft. "X" Licence. By S. G. Wybrow, A.M.I.E.E., A.M.I.M.E.	6	0
Learning to Fly. By F. A. Swoffer, M.B.E. Third Edition	7	6
Light Aero Engines. By C. F. Caunter	12	6
*Pilot's "A" Licence. Compiled by John F. Leeming, *Royal Aero Club Observer for Pilot's Certificates.* Sixth Edition	3	6

MOTOR ENGINEERING, ETC.

	s.	d.
Automobile and Aircraft Engines. By A. W. Judge, A.R.C.S., A.M.I.A.E. Second Edition	42	0
Automobile Engineering. Edited by H. Kerr Thomas, M.I.Mech.E., etc. In seven volumes. Volumes I–VI *Each*	7	6
Volume VII	2	6
Garage Workers' Handbooks. Edited by J. R. Stuart. In seven volumes *Each*	7	6
Supplement to Vol. VII	1	6
Traffic Driving Technique. By Oliver Stewart	5	0
Gas and Oil Engine Operation. By J. Okill, M.I.A.E.	5	0
Pitman's Motor-Cyclists Library *Each*	2	0
A.J.S., The Book of the. By W. C. Haycraft		
Ariel, The Book of the. By W. C. Haycraft		
B.S.A., The Book of the. By "Waysider" (F. J. Camm)		
Douglas, The Book of the. By Fergus Anderson		
New Imperial, Book of the. By F. J. Camm		
Matchless, The Book of the. By W. C. Haycraft		
Norton, The Book of the. By W. C. Haycraft		
Royal Enfield, The Book of the. By R. E. Ryder		
Rudge, The Book of the. By L. H. Cade and F. Anstey		
Sunbeam, The Book of the. By L. K. Heathcote		
Triumph, The Book of the. By E. T. Brown		
Villiers Engine, Book of the. By C. Grange		
Pitman's Motorists Library.		
Austin, The Book of the. By Burgess Garbutt. Revised by E. H. Row. Third Edition	3	6
Book of the B.S.A. Three Wheeler. By Harold Jelley	2	6
Morgan, The Book of the. By G. T. Walton	2	6
Morris Minor, The Book of the. By Harold Jelley and Eric G. Eastwood	2	6
Riley Nine, The Book of the. By R. A. Blake	2	6
Singer Junior, Book of the. By G. S. Davison	2	6
Singer Nine, The Book of the. By R. A. Bishop	2	6
Standard Nine, The Book of the. By J. Speedwell	2	6
Motorist's Electrical Guide, The. By A. H. Avery, A.M.I.E.E.	3	6
Caravanning and Camping. By A. H. M. Ward, M.A.	2	6

OPTICS AND PHOTOGRAPHY

	s.	d.
Amateur Cinematography. By Capt. O. Wheeler, F.R.P.S.	6	0
Applied Optics, Introduction to. By L. C. Martin, D.Sc., A.R.C.S., D.I.C. In two volumes.		
Vol. I. General and Physiological	21	0
Vol. II. Theory and Construction of Instruments	21	0
Bromoil and Transfer. By L. G. Gabriel, B.Sc., Hons.	7	6
Camera Lenses. By A. W. Lockett	2	6
Colour Photography. By Capt. O. Wheeler, F.R.P.S.	12	6
Commercial Cinematography. By G. H. Sewell, F.A.C.I.	7	6
Commercial Photography. By D. Charles. Second Edition	10	6

Optics and Photography—contd.

	s.	d.
Complete Press Photographer, The. By Bell R. Bell	6	0
Industrial Microscopy. By Walter Garner, M.Sc., F.R.M.S.	21	0
Lens Work for Amateurs. By H. Orford. Fifth Edition, Revised by A. Lockett.	3	6
Photographic Chemicals and Chemistry. By J. Southworth and T. L. J. Bentley, D.I.C., A.R.C.Sc., B.Sc.	3	6
Photographic Printing. By R. R. Rawkins	3	6
Photography as a Business. By A. G. Willis	5	0
Photography Theory and Practice. By L. P. Clerc and G. E. Brown	35	0
Retouching and Finishing for Photographers. By J. S. Adamson. Third Edition	4	0
Studio Portrait Lighting. By H. Lambert, F.R.P.S.	15	0
Talking Pictures. By B. Brown, B.Sc. Second Edition	12	6
Talking Pictures and Recording, Amateur. By B. Brown.	7	6

ELECTRICAL ENGINEERING, ETC.

	s.	d.
Acoustical Engineering. By W. West, B.A. A.M.I.E.E.	15	0
Accumulator Charging, Maintenance, and Repair. By W. S. Ibbetson. Fourth Edition	3	6
Alternating Current Bridge Methods. By B. Hague, D.Sc. Third Edition	15	0
Alternating Current Circuit. By Philip Kemp, M.I.E.E.	2	6
Alternating Current Power Measurement. By G F. Tagg	3	6
Alternating Current Work. By W. Perren Maycock, M.I.E.E. Second Edition	7	6
Alternating Currents, The Theory and Practice of. By A. T. Dover, M.I.E.E. Second Edition	18	0
Armature Winding Practical Direct Current. By L. Wollison, A.M.I.E.E.	7	6
Automatic Street Traffic Signalling (Apparatus and Methods). By H. H. Harrison, M.Eng., M.I.E.E., M.I.R.S.E., and T. B. Preist	12	6
Automatic Protective Gear for A.C. Supply Systems. By J. Henderson, M.C., B.Sc., A.M.I.E.E.	7	6
Cables, High Voltage. By P. Dunsheath, O.B.E., M.A., B.Sc., M.I.E.E.	10	6
Continuous Current Motors and Control Apparatus By W. Perren Maycock, M.I.E.E.	7	6
*Definitions and Formulae for Students—Electrical. By P. Kemp, M.Sc., M.I.E.E., Assoc.A.I.E.E.	-	6
*Definitions and Formulae for Students—Electrical Installation Work. By F. Peake Sexton, A.R.C.S., A.M.I.E.E.	-	6
Direct Current Electrical Engineering, Elements of. By H. F. Trewman, M.A., and C. E. Condliffe, B.Sc.	5	0
Direct Current Electrical Engineering, Principles of. By James R. Barr, A.M.I.E.E., and D. J. Bolton, M.Sc., M.I.E.E. Second Edition	21	0

Electrical Engineering, etc.—contd.

	s.	d.
Direct Current Machines, Performance and Design of. By A. E. Clayton, D.Sc., M.I.E.E.	16	0
Dynamo, The: Its Theory, Design, and Manufacture. By C. C. Hawkins, M.A., M.I.E.E. In three volumes. Sixth Edition—		
Vol. I	21	0
Vol. II	15	0
Vol. III	30	0
*Electric and Magnetic Circuits—Alternating and Direct Current, The. By E. N. Pink, B.Sc., A.M.I.E.E.	3	6
Electric Circuit Theory and Calculations. By W. Perren Maycock, M.I.E.E. Third Edition, Revised by Philip Kemp, M.Sc., M.I.E.E., A.A.I.E.E.	7	6
Electric Clocks, Modern. By Stuart F. Philpott, A.M.I.E.E.	7	6
Electric Lighting and Power Distribution. By W. Perren Maycock, M.I.E.E. Ninth Edition, thoroughly Revised by C. H. Yeaman. In two volumes. *Each*	10	6
Electric Machines, Theory and Design of. By F. Creedy, M.A.I.E.E., A.C.G.I.	30	0
Electric Motor Control Gear, Industrial. By W. H. J. Norburn, A.M.I.E.E.	10	6
Electric Motors and Control Systems. By A. T. Dover.	15	0
Electric Motors for Continuous and Alternating Currents, A Small Book on. By W. Perren Maycock, M.I.E.E.	6	0
Electric Traction. By A. T. Dover, M.I.E.E., Assoc. Amer. I.E.E. Second Edition	25	0
Electric Trolley Bus, The. By R. A. Bishop	12	6
Electric Wiring, Fittings, Switches, and Lamps. By W. Perren Maycock, M.I.E.E. Sixth Edition. Revised by Philip Kemp, M.Sc., M.I.E.E.	10	6
Electric Wiring of Buildings. By F. C. Raphael, M.I.E.E.	10	6
Electric Wiring Tables. By W. Perren Maycock, M.I.E.E., Sixth Edition Revised by F. C. Raphael, M.I.E.E.	3	6
Electrical Apparatus, The Calculation and Design of. By W. Wilson, M.Sc., B.E., M.I.E.E., A.Amer.I.E.E.	10	6
Electrical Condensers. By Philip R. Coursey, B.Sc., F.Inst.P., M.I.E.E.	37	6
*Electrical Contracting, Organization, and Routine. By H. R. Taunton	12	6
Electrical Educator. By Sir Ambrose Fleming, M.A., D.Sc., F.R.S. In three volumes. Second Edition	72	0
Electrical Engineering, Classified Examples in. By S. Gordon Monk, M.Sc. (Eng.), B.Sc., A.M.I.E.E. In two parts		
*Vol. I. Direct Current. Third Edition.	2	6
*Vol. II. Alternating Current. Third Edition.	3	6
Electrical Engineering, Experimental. By E. T. A. Rapson, A.C.G.I., D.I.C., A.M.I.E.E.	3	6
Electrical Engineer's Pocket Book, Whittaker's. Originated by Kenelm Edgcumbe, M.I.E.E., A.M.I.C.E. Sixth Edition. Edited by R. E. Neale, B.Sc. (Hons.)	10	6

Electrical Engineering, etc.—contd.

	s.	*d.*
Electrical Guides, Hawkins'. In ten volumes *Each*	5	0
Electrical Machinery and Apparatus Manufacture. Edited by Philip Kemp, M.Sc., M.I.E.E., Assoc.A.I.E.E. In seven volumes *Each*	6	0
Electrical Machines, Practical Testing of. By L. Oulton, A.M.I.E.E., and N. J. Wilson, M.I.E.E. Second Edition	6	0
Electrical Measuring Instruments, Commercial. By R. M. Archer, B.Sc. (Lond.), A.R.C.Sc., M.I.E.E.	10	6
Electrical Power, Transmission, and Interconnection. By C. Dannatt, B.Sc., and J. W. Dalgleish, B.Sc.	30	0
Electrical Technology. By H. Cotton, M.B.E., D.Sc., A.M.I.E.E. Second Edition	12	6
Electrical Terms, A Dictionary of. By S. R. Roget, M.A., A.M.Inst.C.E., A.M.I.E.E. Second Edition	7	6
Electrical Transformer Theory. By S. Gordon Monk	5	0
Electrical Transmission and Distribution. Edited by R. O. Kapp, B.Sc. In eight volumes. Vols. I to VII *Each*	6	0
Vol. VIII	3	0
Electrical Wiring and Contracting. Edited by H. Marryat, M.I.E.E., M.I.Mech.E. In seven volumes *Each*	6	0
Electro-Technics, Elements of. By A. P. Young, O.B.E., M.I.E.E.	5	0
Horse-power Motors, Fractional. By A. H. Avery, A.M.I.E.E.	7	6
Induction Coil, Theory and Applications. By E. Taylor Jones, D.Sc.	12	6
Induction Motor Practice. By R. E. Hopkins, B.Sc., A.M.I.E.E., etc.	15	0
Induction Motor, The. By H. Vickers, Ph.D., M.Eng.	21	0
Meter Engineering. By J. L. Ferns, B.Sc. (Hons.), A.M.C.T.	10	6
Oscillographs. By J. T. Irwin, A.M.I.E.E.	7	6
Photoelectric Cells. By Norman Robert Campbell and Dorothy Ritchie. Third Edition	12	6
Photoelectric Cells Applications. By R. C. Walker, B.Sc., (Lond.), and T. M. C. Lance, Associate I.R.E.	8	6
Power Distribution and Electric Traction, Examples in. By A. T. Dover, M.I.E.E., A.A.I.E.E.	3	6
Power Station Efficiency Control. By John Bruce, A.M.I.E.E.	12	6
Power Wiring Diagrams. By A. T. Dover, M.I.E.E., A.Amer. I.E.E. Second Edition, Revised	6	0
Practical Primary Cells. By A. Mortimer Codd, F.Ph.S.	5	0
Railway Electrification. By H. F. Trewman, A.M.I.E.E.	21	0
Railway Track-Circuits. By D. C. Gall	7	6
Sags and Tensions in Overhead Lines. By C. G. Watson, M.I.E.E.	7	6

Electrical Engineering, etc.—contd.

	s.	d.
Steam Turbo-Alternator, The. By L. C. Grant, A.M.I.E.E.	15	0
Storage Batteries: Theory, Manufacture, Care, and Application. By M. Arendt, E.E.	18	0
Switchgear Design, Elements of. By Dr. Ing. Fritz Kesselring. Translated by S. R. Mellonie, A.M.I.E.E., and J. S. Solomon, B.Sc., A.M.I.E.E.	7	6
Train-lighting, Electric. By C. Coppock	7	6
Transformers for Single and Multiphase Currents. By Dr. Gisbert Kapp, M.Inst.C.E., M.I.E.E. Third Edition, Revised by R. O. Kapp, B.Sc.	15	0
Worked Examples for Wireman and Students. By H. Rees, Grad.I.E.E.	3	6

TELEGRAPHY, TELEPHONY, AND WIRELESS

	s.	d.
Automatic Branch Exchanges, Private. By R. T. A. Dennison	12	6
Automatic Telephony, Relays in. By R. W. Palmer, A.M.I.E.E.	10	6
Cable and Wireless Communications of the World, The. By F. J. Brown, C.B., C.B.E., M.A., B.Sc. (Lond.) Second Edition.	7	6
Radio Communication, Modern. By J. Reyner. Fourth Ed.	5	0
Radio Receiver Servicing and Maintenance. By E. J. G. Lewis	7	6
Radio Upkeep and Repairs for Amateurs. By Alfred Witts, A.M.I.E.E.	5	0
Submarine Telegraphy. By Ing. Italo de Giuli. Translated by J. J. McKichan, O.B.E., A.M.I.E.E.	18	0
Telegraphy. By T. E. Herbert, M.I.E.E. Fifth Edition	20	0
Telegraphy, Elementary. By H. W. Pendry. Second Edition, Revised	7	6
Telephone Handbook and Guide to the Telephonic Exchange, Practical. By Joseph Poole, A.M.I.E.E. (Wh.Sc.). Seventh Edition	18	0
Telephony, By T. E. Herbert, M.I.E.E., and W. S. Procter, A.M.I.E.E. In two volumes. Second Edition.		
Vol. I. Manual Switching Systems and Line Plant	20	0
Vol. II. Automatic Telephony. (*In the Press*)		
Telephony Simplified, Automatic. By C. W. Brown. A.M.I.E.E. Second Edition	6	0
Telephony, The Call Indicator System in Automatic. By A. G. Freestone, *of the G.P.O., London*	6	0
Telephony, The Director System of Automatic. By W. E. Hudson, B.Sc. Hons. (London), Whit.Sch., A.C.G.I.	5	0

Telegraphy, Telephony, and Wireless—contd.

	s.	d.
Television for the Amateur Constructor. By H. J. Barton Chapple	12	6
Television: To-day and To-morrow. By Sydney A. Moseley and H. J. Barton Chapple, Wh.Sc., B.Sc. Fourth Edition	7	6
Wireless Manual, The. By Capt. J. Frost, I.A. (Retired). Revised by H. V. Gibbons. Third Edition	5	0
Wireless Telegraphy and Telephony, Introduction to. By Sir Ambrose Fleming, M.A., D.Sc., F.R.S.	3	6

MATHEMATICS AND CALCULATIONS FOR ENGINEERS

Alternating Currents, Arithmetic of. By E. H. Crapper, D.Sc., M.I.E.E.	4	6
Calculus for Engineers and Students of Science. By John Stoney, B.Sc., A.M.I.Min.E., M.R.San.I. Second Edition	8	6
*Definitions and Formulae for Students—Practical Mathematics. By L. Toft, M.Sc. Second Edition	-	6
Electrical Engineering, Whittaker's Arithmetic of. Fourth Edition, Revised by A. T. Starr, M.A., B.Sc., A.M.I.E.E.	3	6
Exponential and Hyperbolic Functions. By A. H. Bell, B.Sc.	3	6
*Geometry, Building. By Richard Greenhalgh, A.I.Struct.E.	4	6
Geometry, Exercises in Building. By Wilfred Chew	1	6
*Geometry, Test Papers in. By W. E. Paterson, M.A., B.Sc.	2	0
Points Essential to Answers, 1s. In one book	3	0
Graphic Statics, Elementary. By J. T. Wight, A.M.I.Mech.E.	5	0
Graphs of Standard Mathematical Functions. By H. V. Lowry, M.A.	2	0
Logarithms for Beginners. By C. N. Pickworth, Wh.Sc. Eighth Edition	1	6
Logarithms, Five Figure, and Trigonometrical Functions. By W. E. Dommett, A.M.I.A.E., and H. C. Hird, A.F.Ae.S. (Reprinted from *Mathematical Tables*)	1	0
*Logarithms Simplified. By Ernest Card, B.Sc., and A. C. Parkinson, A.C.P. Second Edition	2	0
*Mathematics and Drawing, Practical. By Dalton Grange.	2	0
With Answers	2	6
Mathematics, Building, First Year. By R. C. Smith, M.R.S.T.	3	6
Mathematics, Elementary Practical. Book I. First Year. By E. W. Golding, B.Sc., Tech., A.M.I.E.E., and H. G. Green, M.A.	5	0
Mathematics, Elementary Practical. Book II. Second Year. By E. W. Golding and H. G. Green.	5	0

Mathematics for Engineers—contd.

	s.	d.
Mathematics, Engineering, Application of. By W. C. Bickley, M.Sc.	5	0
Mathematics, Experimental. By G. R. Vine, B.Sc.—		
*Book I, with Answers	1	4
*Book II, with Answers	1	4
Mathematics for Engineers, Preliminary. By W. S. Ibbetson, B.Sc., A.M.I.E.E., M.I.Mar.E.	3	6
Mathematics for Technical Students. By G. E. Hall, B.Sc.	5	0
Mathematics, Practical. By Louis Toft, M.Sc. (Tech.), and A. D. D. McKay, M.A.	16	0
*Mathematics, Industrial (Preliminary), By G. W. Stringfellow	2	0
*With Answers	2	6
Measuring and Manuring Land, and Thatchers' Work, Tables for. By J. Cullyer. Twentieth Impression.	3	0
Mechanical Tables. By J. Foden	2	0
Mechanical Engineering Detail Tables. By John P. Ross	7	6
Metalworker's Practical Calculator, The. By J. Matheson	2	0
*Metric Lengths to Feet and Inches, Table for the Conversion of. Compiled by Redvers Elder	1	0
*Mining Mathematics (Preliminary). By George W. Stringfellow	1	6
*With Answers	2	0
Nomogram, The. By A. J. Allcock, B.Sc., A.M.I.E.E., A.M.I.Mech.E., and J. R. Jones, M.A., F.G.S.	10	6
Reinforced Concrete Members, Simplified Methods of Calculating. By W. N. Twelvetrees, M.I.M.E., A.M.I.E.E. Second Edition, Revised and Enlarged	5	0
Slide Rule, The. By C. N. Pickworth, Wh.Sc. Seventeenth Edition, Revised	3	6
Slide Rule: Its Operations; and Digit Rules, The. By A. Lovat Higgins, A.M.Inst.C.E.	–	6
Steel's Tables. Compiled by Joseph Steel	3	6
Telegraphy and Telephony, Arithmetic of. By T. E. Herbert, M.I.E.E., and R. G. de Wardt	5	0
Trigonometry for Engineers, A Primer of. By W. G. Dunkley, B.Sc. (Hons.)	5	0
Trigonometry for Navigating Officers. By W. Percy Winter, B.Sc. (Hons.), Lond.	10	6
Trigonometry, Practical. By Henry Adams, M.I.C.E., M.I.M.E., F.S.I. Third Edition, Revised and Enlarged	5	0
Ventilation, Pumping, and Haulage, Mathematics of. By F. Birks	5	0
*Workshop Arithmetic, First Steps in. By H. P. Green	1	0

MISCELLANEOUS TECHNICAL BOOKS

	s.	d.
Boot and Shoe Manufacture. By Frank Plucknett	35	0
Bowls: How to Improve Your Game. By H. P. Webber and J. W. Fisher	1	6
Bowls, The Modern Technique of. By H. P. Webber and Dr. J. W. Fisher	7	6
Brewing and Malting. By J. Ross Mackenzie, F.C.S., F.R.M.S. Third Edition	10	6
Builder's Business Management. By J. H. Bennetts, A.I.O.B.	10	6
Cellulose Lacquers. By S. Smith, O.B.E., Ph.D.	7	6
Cinema Organ, The. By Reginald Foort, F.R.C.O.	2	6
Cost Accounts in Rubber and Plastic Trades. By T. W. Fazakerley	5	0
Electrical Housecraft. By R. W. Kennedy	2	6
*Engineering Economics. By T. H. Burnham, B.Sc. (Hons.), B.Com., A.M.I.Mech.E. Second Edition	10	6
Engineering Inquiries, Data for. By J. C. Connan, B.Sc., A.M.I.E.E., O.B.E.	12	6
Faraday, Michael, and Some of His Contemporaries. By William Cramp, D.Sc., M.I.E.E.	2	6
Glue and Gelatine. By P. I. Smith	8	6
Gramophone Handbook, The. By W. S. Rogers.	2	6
Hairdressing, The Art and Craft of. Edited by G. A. Foan	60	0
Hiker and Camper, The Complete. By C. F. Carr	2	6
House Decorating, Practical. By Millicent Vince	3	6
Motor Boating. By F. H. Snoxell	2	6
Paper Testing and Chemistry for Printers. By G. A. Jahans, B.A.	12	6
Petroleum. By Albert Lidgett. Third Edition.	5	0
Plan Drawing for the Police. By James D. Cope, P.A.S.I.	2	0
Power Economy in the Factory. By J. C. Todman, F.C.W.A.	7	6
Precious and Semi-Precious Stones. By M. Weinstein. 2nd Ed.	7	6
Printing. By H. A. Maddox. Second Edition	5	0
Printing, The Art and Practice of. Edited by Wm. Atkins. In six volumes . *Each*	7	6
Refractories for Furnaces, Crucibles, etc. By A. B. Searle	5	0
Refrigeration, Mechanical. By Hal Williams, M.I.Mech.E., M.I.E.E., M.I.Struct.E. Fourth Edition	20	0
Seed Testing. By J. Stewart Remington	10	6
Shoe Repairer's Handbooks. By D. Laurence-Lord. In seven volumes. *Each*	3	6
Teaching Methods for Technical Teachers. By J. H. Currie, M.A., B.Sc., A.M.I.Mech.E.	2	6
Upland Rambles in Surrey and Sussex. By Harold Shelton, B.A.	3	6
With the Watchmaker at the Bench. By Donald de Carle, F.B.H.I.	7	6

PITMAN'S TECHNICAL PRIMERS

s.

Each in foolscap 8vo, cloth, about 120 pp., illustrated . . 2

The Technical Primer Series is intended to enable the reader to obtain an introduction to whatever technical subject he desires.

Abrasive Materials. By A. B. Searle.

A.C. Protective Systems and Gears. By J. Henderson, B.Sc., M.C., and C. W. Marshall, B.Sc., M.I.E.E.

Belts for Power Transmission. By W. G. Dunkley, B.Sc.

Boiler Inspection and Maintenance. By R. Clayton.

Capstan and Automatic Lathes. By Philip Gates.

Central Stations, Modern. By C. W. Marshall, B.Sc., M.I.E.E. Second Edition

Continuous Current Armature Winding. By F. M. Denton, A.C.G.I., A.Amer.I.E.E.

Continuous Current Machines, The Testing of. By Charles F. Smith, D.Sc., M.I.E.E., A.M.I.C.E.

Cotton Spinning Machinery and Its Uses. By Wm. Scott Taggart, M.I.Mech.E.

Diesel Engine. The. By A. Orton.

Drop Forging and Drop Stamping. By H. Hayes.

Electric Cables. By F. W. Main, A.M.I.E.E. Second Edition.

Electric Cranes and Hauling Machines. By F. E. Chilton, A.M.I.E.E.

Electric Furnace, The. By Frank J. Moffett, B.A., M.I.E.E.

Electric Motors, Small. By E. T. Painton, B.Sc., A.M.I.E.E.

Electrical Insulation. By W. S. Flight, A.M.I.E.E.

Electrical Transmission of Energy. By W. M. Thornton, O.B.E., D.Sc., M.I.E.E.

Electricity in Agriculture. By A. H. Allen, M.I.E.E.

Electricity in Steel Works. By Wm. McFarlane, B.Sc.

Electrification of Railways. By H. F. Trewman, M.A.

Electro-Deposition of Copper, The. By C. W. Denny.

Explosives, Manufacture and Uses of. By R. C. Farmer, O.B.E., D.Sc., Ph.D.

Filtration. By T. R. Wollaston, M.I.Mech.E.

Foundrywork. By Ben Shaw and James Edgar.

Grinding Machines and Their Uses. By Thos. R. Shaw.

Hydro-Electric Development. By J. W. Meares, F.R.A.S.

Industrial and Power Alcohol. By R. C. Farmer, O.B.E., D.Sc., Ph.D., F.I.C.

Industrial Nitrogen. By P. H. S. Kempton, B.Sc. (Hons.).

Kinematograph Studio Technique. By L. C. Macbean.

Lubricants and Lubrication. By J. H. Hyde.

Mechanical Handling of Goods, The. By C. H. Woodfield.

Mechanical Stoking. By D. Brownlie, B.Sc., A.M.I.M.E. (Double volume, price 5s. net.)

Metallurgy of Iron and Steel. Based on Notes by Sir Robert Hadfield.

Pitman's Technical Primers—contd. s. d.

Municipal Engineering. By H. Percy Boulnois, M.Inst.C.E. 2 6

Oils, Pigments, Paints, and Varnishes. By R. H. Truelove.

Patternmaking. By Ben Shaw and James Edgar.

Photographic Technique. By L. J. Hibbert, F.R.P.S. Second Edition.

Pneumatic Conveying. By E. G. Phillips, M.I.E.E.

Power Factor Correction. By A. E. Clayton, B.Sc. (Eng.). Second Edition.

Radioactivity and Radioactive Substances. By J. Chadwick, M.Sc., Ph.D. Fourth Edition.

Railway Signalling: Automatic. By F. Raynar Wilson.

Sewers and Sewerage. By H. Gilbert Whyatt, M.I.C.E., F.R.San.I. Third Edition.

Sparking Plugs. By A. P. Young and H. Warren.

Steam Locomotive, The. By E. L. Ahrons.

Steam Locomotive Construction and Maintenance. By E. L. Ahrons, M.I.Mech.E., M.I.Loco.E.

Steelwork, Structural. By Wm. H. Black.

Streets, Roads, and Pavements. By H. Gilbert Whyatt, M.Inst.C.E., F.R.San.I. Third Edition.

Switchgear, High Tension. By Henry E. Poole, B.Sc.(Hons.).

Switching and Switchgear. By Henry E. Poole, B.Sc.(Hons.).

Telephones, Automatic. By F. A. Ellson, B.Sc., A.M.I.E.E. (Double volume, price 5s.)

Tidal Power. By A. M. A. Struben, O.B.E., A.M.Inst.C.E.

Tool and Machine Setting. By Philip Gates.

Traction Motor Control (Direct Current). By A. T. Dover, M.I.E.E.

Transformers and Alternating Current Machines, The Testing of. By Charles F. Smith, D.Sc., A.M.Inst.C.E.

Transformers, High Voltage Power. By Wm. T. Taylor. M.Inst.C.E., M.I.E.E.

Transformers, Small Single-Phase. By Edgar T. Painton, B.Sc. Eng. (Hons.) Lond., A.M.I.E.E.

Water Power Engineering. By F. F. Fergusson, C.E., F.G.S., F.R.G.S. Third Edition.

Wireless Telegraphy, Continuous Wave. By B. E. G. Mittell, A.M.I.E.E.

X-Rays, Industrial Application of. By P. H. S. Kempton, B.Sc. (Hon.)., A.R.C.Sc.

COMMON COMMODITIES AND INDUSTRIES SERIES

s. d.

Each book is crown 8vo, cloth, with many illustrations, etc. . 3 0
In each of the handbooks in this series a particular product or industry is treated by an expert writer and practical man of business.

Asbestos. By A. Leonard Summers.

Bookbinding Craft and Industry, The. By T. Harrison.

Books: From the MS. to the Bookseller. By J. L. Young. Second Edition.

Boot and Shoe Industry, The. By J. S. Harding, F.B.S.I. Second Edition.

Brushmaker. The. By Wm. Kiddier.

Butter and Cheese. By C. W. Walker Tisdale, F.C.S., and Jean Jones, B.D.F.D., N.D.D. Second Edition.

Carpets. By Reginald S. Brinton. Second Edition.

Clocks and Watches. By G. L. Overton.

Cloths and the Cloth Trade. By J. A. Hunter.

Clothing Industry, The. By B. W. Poole.

Coal. Its Origin, Method of Working, and Preparation for the Market. By Francis H. Wilson, M.Inst.M.E. Second Edition.

Coal Tar. By A. R. Warnes, F.I.C., A.Inst.P., etc.

Coffee. From the Grower to Consumer. By B. B. Keable. Revised by C. J. Parham.

Concrete and Reinforced Concrete. By W. Noble Twelvetrees, M.I.M.E., A.M.I.E.E.

Copper. From the Ore to the Metal. By H. K. Picard, M.I.M.M.

Cordage and Cordage Hemp and Fibres. By T. Woodhouse and P. Kilgour.

Corn Trade, The British. By A. Barker.

Cotton Spinning. By A. S. Wade.

Engraving. By T. W. Lascelles.

Explosives, Modern. By S. I. Levy, B.A., B.Sc., F.I.C.

Fishing Industry, The. By W. E. Gibbs, D.Sc.

Furniture. By H. E. Binstead. Second Edition.

Furs and the Fur Trade. By J. C. Sachs. Third Edition.

Gas and Gas Making. By W. H. Y. Webber, C.E.

Glass and Glass Manufacture. By P. Marson. Second Edition Revised by L. M. Angus-Butterworth, F.R.G.S., F.Z.S., etc.

Gloves and the Glove Trade. By B. E. Ellis.

Common Commodities Series—contd.

s. d.

Gums and Resins. Their Occurrence, Properties, and Uses. By Ernest J. Parry, B.Sc., F.I.C., F.C.S. 3 0

Iron and Steel. Their Production and Manufacture. By C. Hood.

Ironfounding. By B. Whiteley.

Jute Industry, The. By T. Woodhouse and P. Kilgour.

Knitted Fabrics. By John Chamberlain and James H. Quilter.

Leather. From the Raw Material to the Finished Product. By K. J. Adcock. Second Edition.

Linen. From the Field to the Finished Product. By Alfred S. Moore.

Locks and Lock Making. By F. J. Butter. Second Edition.

Match Industry, The. By W. H. Dixon.

Meat Industry, The. By Walter Wood.

Oils. Animal, Vegetable, Essential, and Mineral. By C. Ainsworth Mitchell, M.A., F.I.C.

Paper. Its History, Sources, and Production. By Harry A. Maddox, *Silver Medallist Papermaking*. Third Edition.

Photography. By William Gamble, F.R.P.S.

Pottery. By C. J. Noke and H. J. Plant.

Rice. By C. E. Douglas, M.I.Mech.E.

Rubber. Production and Utilization of the Raw Product. By H. P. Stevens, M.A., Ph.D., F.I.C., and W. H. Stevens, A.R.C.Sc., A.I.C. Third Edition.

Salt. By A. F. Calvert, F.C.S.

Silk. Its Production and Manufacture. By Luther Hooper.

Soap. Its Composition, Manufacture, and Properties. By William H. Simmons, B.Sc. (Lond.), F.I.C., F.C.S. Third Edition.

Sponges. By E. J. J. Cresswell. Second Edition.

Stones and Quarries. By J. Allen Howe, O.B.E., B.Sc., M.Inst. Min. and Met.

Sugar. Cane and Beet. By the late Geo. Martineau, C.B., and Revised by F. C. Eastick, M.A. Sixth Edition.

Sulphur and the Sulphur Industry. By Harold A. Auden, M.Sc., D.Sc., F.C.S.

Tea. From Grower to Consumer. By A. Ibbetson.

Textile Bleaching. By Alex. B. Steven, B.Sc. (Lond.), F.I.C.

Timber. From the Forest to Its Use in Commerce. By W. Bullock. Second Edition.

Tin and The Tin Industry. By A. H. Mundey. Second Edition.

Common Commodities Series—contd.

	s.
TOBACCO. From Grower to Smoker. By A. E. Tanner. Third Revised Edition.	3
WEAVING. By W. P. Crankshaw.	
WHEAT AND ITS PRODUCTS. By Andrew Millar.	
WOOL. From the Raw Material to the Finished Product. By J. A. Hunter.	
WORSTED INDUSTRY, THE. By J. Dumville and S. Kershaw. Third Edition.	

RAW MATERIALS OF COMMERCE

Edited by J. H. VANSTONE, F.R.G.S. Assisted by Specialist Contributors.

In two volumes, demy 4to, cloth gilt, 804 pp., with numerous illustrations. Complete 20s. net.

A descriptive account of the vegetable, animal, mineral, and synthetic products of the world and of their commercial uses.

The following Catalogues will be sent post free on application

Scientific and Technical, Educational, Commercial, Law, Shorthand, Foreign Languages, Arts and Crafts, and General

PITMAN'S SHORTHAND

INVALUABLE TO ALL BUSINESS AND PROFESSIONAL MEN

DEFINITIONS AND FORMULAE FOR STUDENTS

This series of booklets is intended to provide students with all necessary definitions and formulae in a convenient form.

AERONAUTICS. By J. D. Frier, A.R.C.Sc., D.I.C.
APPLIED MECHANICS. By E. H. Lewitt, B.Sc., A.M.I.Mech.E.
BUILDING. By T. Corkhill, F.B.I.C.C., M.I.Str.E.
CHEMISTRY. By W. G. Carey, F.I.C.
COAL MINING. By M. D. Williams, F.G.S.
ELECTRICAL. By Philip Kemp, M.Sc., M.I.E.E., Assoc.A.I.E.E.
ELECTRICAL INSTALLATION WORK. By F. Peake Sexton, A.R.C.S., A.M.I.E.E.
HEAT ENGINES. By Arnold Rimmer, B.Eng.
LIGHT AND SOUND. By P. K. Bowes, M.A., B.Sc.
MARINE ENGINEERING. By E. Wood, B.Sc.
METALLURGY, By E. R. Taylor, A.R.S.M., F.I.C., D.I.C.
PRACTICAL MATHEMATICS. By Louis Toft, M.Sc.

Each about 32 pp. Price 6d.

PITMAN'S

TECHNICAL DICTIONARY OF *ENGINEERING AND INDUSTRIAL SCIENCE*

IN SEVEN LANGUAGES

ENGLISH, FRENCH, SPANISH, ITALIAN, PORTUGUESE, RUSSIAN, AND GERMAN

WITH AN INDEX TO EACH LANGUAGE

Edited by

ERNEST SLATER, M.I.E.E., M.I.Mech.E.

In Collaboration with Leading Authorities

Complete in five volumes. Crown 4to, buckram gilt, £8 8s. net.

SIR ISAAC PITMAN & SONS, LTD., PARKER STREET, KINGSWAY, W.C.2

MADE IN GREAT BRITAIN AT THE PITMAN PRESS, BATH